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OVERHEAD WATER TANK LEVEL MONITORING & MOTOR CONTROL USING ARDUINO

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Abstract: This project presents the design and implementation of an automatic overhead water tank level monitoring and motor controlling system using an Arduino Uno (ATmega328P). The system aims to eliminate the need for manual water level checking and motor operation, thereby preventing overflow, dry running, and unnecessary power usage.
An **ultrasonic sensor (HC-SR04)** is used to measure the water level in the tank without physical contact. Based on the measured level, the **Arduino** processes the data and automatically controls a **relay module** that switches the water pump ON or OFF. A **16×2 LCD with an I2C interface** provides real-time display of water level percentage and motor status.
The system is low-cost, reliable, and energy-efficient, making it suitable for domestic, agricultural, and industrial applications. It ensures optimal water usage while protecting the motor from damage due to dry run or overfilling. This work demonstrates a practical, scalable, and smart solution for efficient water resource management.

KEYWORDS: Arduino uno, ultrasonic sensor, 16×2 display with I2C, Relay Module, Water Pump

I INTRODUCTION

Water is one of the most essential resources for life, and its efficient usage and management are crucial, especially in areas facing scarcity. In many households, agricultural fields, and commercial buildings, overhead tanks are used to store water. However, monitoring the water level in these tanks manually is inefficient, time-consuming, and often leads to problems such as water overflow, dry running of motors, and unnecessary electricity consumption.
To address these issues, automation in water tank level monitoring and motor control offers a practical solution. This project proposes a simple, cost-effective, and reliable system using Arduino Uno, an ultrasonic sensor (HC-SR04), a relay module, and a 16×2 LCD with I2C. The system continuously monitors the water level in the tank and automatically switches the motor ON or OFF based on predefined thresholds. The current status of the tank and motor is also displayed in real time on the LCD screen.
By eliminating human error and effort, this automated system ensures effective water usage, prevents overflow and motor damage, and reduces energy consumption. Furthermore, it forms the basis for more advanced smart systems by allowing integration with IoT for remote monitoring in the future.

2.1 WATER AVAILABILITY:

Water is a finite and vital natural resource that supports life, agriculture, industry, and the environment. Despite covering nearly 71% of the Earth's surface, only **2.5% of the world's water** is freshwater, and less than 1% is readily accessible for human use in lakes, rivers, and underground aquifers.
In many parts of the world, especially in developing countries, **water scarcity** is a growing concern due to factors like population growth, urbanization, climate change, and mismanagement. Rural areas often depend on borewells and stored tank water for daily use, while urban regions face challenges in managing water supply and distribution efficiently.

2.2 TYPES OF MONITORING SYSTEM

Water level monitoring can be found in many areas since before. The history of water level monitoring and controlling system are classified based on:

- Control of System
- Method of Automation

2.2.1 BASED ON THE CONTROL OF SYSTEM

A control system commands, directs, regulated, and control manages the behaviour of any system using control system. Types of levl monitoring system based on control system

- Individual Control System
- Large Control System
- Central Control System

2.2.1.1. Individual Control System

A standalone system that monitors and controls the water level of a single tank or unit independently. It uses a dedicated microcontroller (e.g., Arduino) and sensors to automate water pump operation.

2.2.1.2. Large Control System

A system designed to handle multiple tanks or water sources across a large area (e.g., an industrial plant or a large farm). May involve multiple microcontrollers or sensors working together and sharing data across different zones.

2.2.1.3. Central Control System

A **centralized** system where multiple tanks or control units are monitored and controlled from a **single command center**. Data from various tanks is sent to a central microcontroller or server. Control decisions (like turning motors on/off) are made at the central location.

2.2.2. BASED ON THE METHOD OF AUTOMATION OF SYSTEM:

Automation refers to the use of technology to perform tasks with minimal human intervention. Water level monitoring systems can be categorized based on the **degree and type of automation** they employ. These classifications help in understanding how manual or intelligent a system is in its operation.

- Bluetooth Based Water Level Monitoring
- Remote Water level Monitoring
- Automatic Water Level Monitoring

2.2.2.1. Bluetooth Based Water Level Monitoring

This system uses a **Bluetooth module (e.g., HC-05)** to communicate wirelessly with a mobile device within a short range.
The Arduino collects data from water level sensors and sends it via Bluetooth to a smartphone app.

2.2.2.2. Remote Water level Monitoring

This system uses **GSM**, **Wi-Fi (ESP8266/Node MCU)**, or **cloud platforms** to enable **remote control and monitoring** from anywhere.
Water level data is sent to a cloud or mobile app; user can view tank level, receive alerts, and control the pump remotely.

2.2.2.3. Automatic Water Level Monitoring

A **fully automated local system** where the **Arduino** monitors water level and controls the motor using sensors and a relay—**no user interaction** needed. When the water falls below a set level, the motor turns ON automatically; when the tank is full, the motor turns OFF.

2.3. PREVIOUS EXPERIMENTAL WORKS:

Numerous studies and practical experiments have been conducted in recent years to develop efficient, automated water level monitoring and control systems. Below are some notable implementations based on different techniques and technologies:

2.3.1 Liquid Level Control

This system focuses on maintaining a liquid (usually water) level within a defined range using basic sensors and control logic. It generally involves a simple float sensor or conductive probes that detect specific levels and trigger a motor or valve accordingly. These systems are widely used in water tanks, chemical plants, and fuel storage facilities.

2.3.2 Low-Cost Automatic Water Level Control for Domestic Purpose

This model uses basic electronic components like transistors, relays, and water level probes to create a cost-effective solution for home use. The system automatically turns ON the pump when the water level is low and OFF when the tank is full.

2.3.3 Electric Water Pump Controller and Indicator

This design integrates level detection with visual indicators (LEDs) and a relay-based motor controller. The user is alerted with light signals about water levels, and the motor operates automatically depending on sensor inputs.

2.3.4 Microcontroller-Based Water Level Control System

These systems use microcontrollers (like 8051, PIC, or Arduino) to control pump operations based on real-time sensor inputs. The system can also integrate LCDs for displaying water level and status.

2.3.5 Logic Gate-Based Water Level Controller

This approach uses digital logic gates (AND, OR, NOT) to control water pump activation without a microcontroller. While it offers basic automation, it lacks adaptability and complex decision-making.

2.4 PREVIOUS RESEARCH PAPERS:

Several research papers have contributed significantly to the development and evolution of water level monitoring and automation systems. These studies explore various approaches such as automation, communication integration, and microcontroller-based control logic. A few notable research works are summarized below:

2.4.1 Design and Development of Automatic Water Flow Meter

This paper presents the development of a **low-cost digital water flow meter** that measures the flow rate and total volume of water using a **flow sensor** connected to a **microcontroller (Arduino)**. It focuses on real-time water usage tracking and display on an LCD.

2.4.2 Automatic Water Level Controller with SMS Notification

The paper describes a **GSM-based system** that not only controls the water level but also sends **SMS alerts** to users when the tank is full or empty. A **microcontroller** and **GSM module** are used to handle sensor data and messaging functionality.

2.4.3 Automatic Water Level Control System

This research focuses on a **fully automated system** using sensors and relays to control the motor based on the tank's water level. The design used simple electronic components and microcontroller logic to start/stop the pump automatically.

3.1 PROBLEM STATEMENT:

Manual monitoring of overhead water tank levels is still common in many households, farms, and institutions. This traditional approach leads to several practical issues:

- Water wastage due to **overflow** when the motor is left ON.
- **Motor damage** due to dry running when the tank is empty.
- **Human dependency** for switching ON/OFF the motor.
- **Inefficient power usage**, increasing electricity bills.
- Lack of real-time **feedback or alerts** about water level status.

3.2 Drawbacks in Previous Works

While several systems have been developed to address water tank automation, many had limitations, such as:

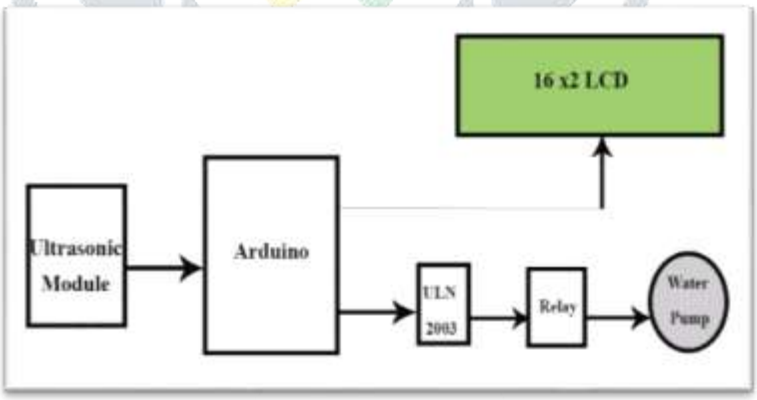
- Use of **contact-type sensors** (e.g., metal probes or float switches), which corrode over time and require regular maintenance.
- **GSM-based systems** are effective but costly and depend on network availability.
- **Manual systems** require constant human attention, which can be error-prone.
- **Basic automatic systems** lack real-time displays or alerts, reducing user awareness.
- **Logic gate-based systems** are rigid and cannot be easily modified or scaled.

3.3 Overcoming the Drawbacks

The proposed Arduino-based system overcomes these limitations by:

- Using a **non-contact ultrasonic sensor**, which is more durable and maintenance-free.
- Automating motor control using a **relay module**, removing the need for manual switching.
- Displaying real-time tank status on a **16×2 LCD with I2C module**.
- Making the system **low-cost, power-efficient, and user-friendly**.

3.4. BLOCK DIAGRAM:



1. **Power Supply Initialization**

   The entire system is powered using a regulated **5V or 12V power supply** which energizes the Arduino Uno and connected modules.
2. **Water Level Sensing**
   - The **HC-SR04 Ultrasonic Sensor** is placed at the top of the water tank.
   - It continuously emits sound waves and measures the time taken for the echo to return.
   - Arduino calculates the **distance to the water surface** and thus estimates the water level in the tank.
3. **Data Processing (Arduino Uno)**
   - The **Arduino Uno (ATmega328P)** receives the data from the sensor.
   - It checks if the water level is **below the minimum threshold** or **above the maximum level**.
4. **Motor Control (via Relay)**
   - If the water level is **low**, the Arduino sends a signal to the **relay module** to turn **ON the water pump**.
   - If the water level is **high**, it turns **OFF the motor** to avoid overflow.
5. **Output Actions**
   - The **relay module** acts as a switch to control the pump.
   - The pump fills the tank automatically when required and stops when the tank is full.

4. Literature Survey

1. Amandeep Kaur, Ravinder Singh, and Priya Sharma (2016)

In their paper “Design and Implementation of Water Level Controller using Arduino” published in the International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE), the authors presented a system based on the Arduino UNO microcontroller and basic level sensors. The system enabled automatic motor control by detecting the water level through a set of contact-based metal probes. Despite the simplicity of the approach, the study highlighted the limitations of contact sensors—mainly corrosion and maintenance. However, it laid a foundation for automation in water systems in domestic use cases by promoting microcontroller-based designs.

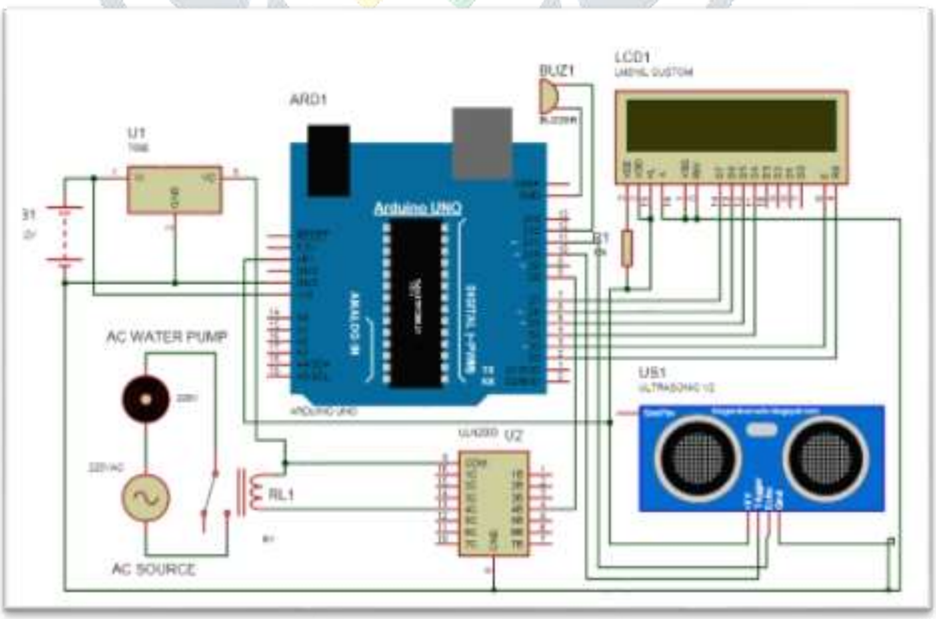
2. S. Nandhini and D. Sangeetha (2018)
Their work titled "Automated Water Tank Level Monitoring System using IoT" in the International Journal of Scientific & Engineering Research (IJSER) focused on integrating Internet of Things (IoT) technologies into traditional water level control systems. The proposed design utilized ultrasonic sensors and an ESP8266 Wi-Fi module to send tank data to a cloud server, allowing real-time monitoring via a smartphone app. This system introduced remote alerts and monitoring, addressing the limitations of traditional manual systems, and providing an efficient and user-friendly interface for smart water management.

3. P. N. Verma and D. R. Kalbande (2017)
In the paper "Automatic Water Level Controller using Arduino" published in the International Journal of Engineering Research and Technology (IJERT), the researchers explored a low-cost automation system using an Arduino UNO and float-type water level sensors. The system used relay modules to switch the motor ON/OFF based on sensor inputs and provided visual status via LEDs. Although float sensors are prone to mechanical issues, the paper reinforced the feasibility and affordability of basic automation for rural and semi-urban applications.

4. Md. Tamjidul Hoque, Mohammad Hasanuzzaman et al. (2020)
In their IEEE paper "Smart Water Tank Monitoring System using GSM Technology", the authors implemented a GSM-based system for remote water tank monitoring. Their system sent SMS alerts to users about the water level and pump status, integrating real-time communication through a SIM800L module. The study demonstrated the advantage of mobile connectivity in regions without internet, although at a higher cost. It also discussed power efficiency and suggested future integration with solar energy sources.

5. D. Satish and M. Harsha Vardhan (2019)
Published in the International Journal of Innovative Technology and Exploring Engineering (IJITEE), this paper titled "Water Level Monitoring System Using Ultrasonic Sensor and GSM Module" presented a solution combining HC-SR04 ultrasonic sensors with GSM for long-distance communication. The authors provided detailed hardware implementation and analysis of performance in different environmental conditions. They observed that ultrasonic sensors were superior to traditional methods due to their non-contact measurement and reliability, especially for turbid water conditions.

5.1 SCHEMATIC DIAGRAM



5.2 COMPONENTS:
The components that are used for the hardware implementation of our paper are

- Arduino UNO
- Ultrasonic Sensor
- Relay Module
- 16×2 LCD display with I2C
- Submersible Water Pump

6.RESULT:

"Overhead Water Tank Level Monitoring and Motor Controlling using Arduino Uno", the system was tested under various water level conditions. The results validate the **efficiency, automation, and reliability** of the designed model.

Case 1: Water Tank Full

- **Measured Distance**: Less than 10 cm

Case 2: Water Tank at Intermediate Level

- **Measured Distance**: Between 10 cm and 100 cm

Case 3: Water Tank Empty or Low

- **Response**:
  The Arduino activates the relay module, which turns ON the motor. The pump begins to fill the tank until a higher level is detected.
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