AN INNOVATIVE APPROACH TO WATER TANK MONITORING USING ULTRASONIC SENSOR

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Abstract - This paper presents the design and implementation of an Ultrasonic Water Tank Monitoring System, a novel approach to water management and conservation. The system leverages ultrasonic sensor technology to accurately measure water levels in real-time, providing critical data for efficient water usage and management. The system's innovative design allows for easy installation and operation in various types of water tanks, making it a versatile solution for both residential and industrial applications. The system also incorporates a user- friendly interface, enabling users to monitor water levels remotely and receive alerts when levels approach critical thresholds. Preliminary testing results indicate that the system performs reliably under various conditions, demonstrating its potential as a valuable tool for sustainable water management. Further research is proposed to enhance the system's capabilities and explore its potential applications in other areas of water resource management.

***Key Words*: Ultrasonic sensor, Manual and Auto mode, LCD display, Pump, Relay Board**

1. INTRODUCTION

Water is a vital resource, and its efficient management is crucial for sustainability. With the advent of the Internet of Things (IoT) and advancements in sensor technology, it is now possible to monitor and manage water resources more effectively. This paper focuses on the development and implementation of a water tank monitoring system using ultrasonic sensors. The proposed system aims to provide a solution for efficient water management in residential, commercial, and industrial settings. The system is designed to automatically monitor the water level and provide alerts when the water level reaches critical thresholds. This not only ensures a constant supply of water but also helps in preventing water wastage. Furthermore, the system can be integrated with IoT technologies, allowing users to monitor the water level remotely and receive real-time updates. This paper presents a comprehensive study of the design, implementation, and performance evaluation of the proposed water tank monitoring system. It contributes to the existing body of knowledge by providing insight into the practical challenges and solutions related to the implementation of ultrasonic sensor-based water level monitoring systems.

1.1 Objectives

1. Develop a Real-Time monitoring system.
2. Optimize water usage with adaptability.
3. Measure and display water level in percentage on LCD display.
4. Provide manual and automatic mode for the user.

1.2 Literature Review

Ultrasonic Technology in Water Tank Monitoring: Ultrasonic technology, based on the principle of measuring sound waves' travel time, has gained popularity in water tank monitoring due to its accuracy and non-invasiveness. Researchers have extensively explored the use of ultrasonic sensors to measure water levels, offering a reliable and contactless method for data collection.

Applications of Ultrasonic Water Tank Monitoring Systems:

Numerous applications of ultrasonic water tank monitoring systems have been identified in various sectors. In agriculture, these systems assist farmers in optimizing irrigation schedules by providing precise information on water levels. Municipalities utilize them to monitor water storage in reservoirs and distribution systems, aiding in the prevention of water shortages and leak detection. Additionally, industries benefit from these systems to ensure a steady water supply for manufacturing processes.

Integration with IoT and Cloud Computing:

Recent advancements in Internet of Things (IoT) and cloud computing technologies have significantly enhanced the capabilities of ultrasonic water tank monitoring systems. Integration with IoT enables real-time data transmission, remote monitoring, and data analytics. Cloud-based platforms facilitate data storage, accessibility, and collaboration, allowing stakeholders to make informed decisions based on historical and real- time water level data.

Energy-Efficient Designs and Power Management: Efforts have been made to develop energy-efficient ultrasonic water tank monitoring systems to prolong battery life and reduce environmental impact. Low-power microcontrollers, sleep modes, and optimized signal processing algorithms contribute to efficient power management, ensuring the sustainability of these monitoring systems in off-grid or remote locations.

Challenges and Future Directions:

Despite the advancements, challenges persist in the development and deployment of ultrasonic water tank monitoring systems. Issues such as signal interference, calibration drift, and environmental factors can affect the accuracy of measurements. Future research should focus on addressing these challenges and exploring new technologies to enhance the reliability and robustness of ultrasonic monitoring systems.

Conclusion:

The literature review highlights the significance of ultrasonic water tank monitoring systems in addressing water management challenges. Proposed system highlights water level monitoring along with manual and automatic both mode with good accuracy. With continuous advancements in sensor technologies, integration with IoT, and improvements in power management, these systems offer valuable insights for efficient water resource management.

2. DESIGN AND IMPLEMENTATION OF PROPOSED SYSTEM

1) ARDUINO UNO BOARD

The Arduino Uno lies the Atmega328P microcontroller, which provides processing power and I/O capabilities for controlling electronic components. The Uno board features a set of digital input/output (I/O) pins (14 in total), which can be configured as either inputs or outputs, allowing it to interface with various digital sensors, LEDs, motors, and other peripherals. Additionally, it includes six analog input pins, enabling the reading of analog sensors. The Uno can be easily connected to a computer via USB, allowing for programming and communication with the board. Arduino provides a user-friendly IDE that simplifies the process of writing, compiling, and uploading code to the Uno board. Arduino Uno is compatible with a wide range of expansion boards called "shields," which add additional functionalities such as wireless communication (Wi-Fi, Bluetooth) and many more.

Fig: Arduino Uno

2) RELAY BOARD

Relays are electromechanical switches that open or close circuits based on the application of a control signal. They consist of an electromagnetic coil that, when energized, generates a magnetic field, causing movable contacts to change position. These contacts physically connect or disconnect the circuit. In this instance, we controlled a 240V pump using a four-channel 5V relay board. Maximum current for the relay is 10A at 250 volts AC or 10A at 30 volts DC. This board has three high-power connections: Common (COM), Normally Open (NO), and Normally Closed (NC) with 5V VCC, GND, and control pins.

Fig: Relay board

3) 16×2 LCD DISPLAY WITH I2C INTERFACE

16×2 displays are commonly used in various electronic devices, such as digital clocks, electronic meters, small appliances, and DIY electronics projects, due to their simplicity, low power consumption, and ease of interfacing with microcontrollers or other control circuits. These modules are superior to seven-segment and other multi-segment LEDs due to their cost-effectiveness and simplicity in programming for characters and graphics.

The ultrasonic sensor on top keeps track of the water level in the tank continuous. As the water level in the tank drops below 30 percent, the pump is turned on using the relay mechanism and is kept on until the tank is full. . After that, the pump is shut off, and the loop is repeated. This Project focuses on implementing an Arduino-based system to monitor the water level in a tank using an ultrasonic sensor, which also controls a relay-connected pump based on the input from the sensor. The entire tank height is used to determine the water levels. The lower level is at 30 percent of the total height, and the upper level is set at 90 percent of the total tank height. When the tank is 30 percent full, the distance between the sensor and the water surface will be

h30%= Total height – height of 30% filled water)

Similarly, when the tank is 90 percent full, the distance between the sensor and the water surface will be:

(h90%= Total height – height of 90% filled water)

When the distance of the water surface from the ultrasonic sensor is greater than h30%, the pump is on.

The pump is automatically turned off after it reaches the predetermined upper water level.. This happens when the distance of the water surface from the ultrasonic sensor is less than h90%. The ultrasonic sensor's Echo and Trigger pins are connected to pins 8 and 9 of the Arduino board respectively. Now, connect pin 13 of the Arduino to the input pin of the relay board. Attach the pump to the relay board's AC circuit. Consider relay as switch. The LCD module, equipped with an I2C interface can be connected by using only two analog pins, which in this case are connected to the A0 and A1 pins of the Arduino board. Now, provide the +Vcc and GND connections to the ultrasonic sensor, relay board, and LCD module using +5V and GND from Arduino. We also have the push button and a SPST switch at pin 10 and 14 respectively which help us to switch between the auto/manual modes for the pump operation.

Fig: Proposed system

3. CONCLUSION

This Project is based on the tank monitor system gives real-time information about the current water level in the tank and also automates the process of filling the water tank, just like the actual plant. An Arduino UNO board is the brain of the system, which takes input from the ultrasonic sensor, processes it and displays it on an LCD module, and also controls the pump via a relay board accordingly.

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