IoT-Based Water Monitoring System for Automatic Pump Operation

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***Abstract*—The Manson IoT- Based Water Monitoring System for Automatic Pump Operation offers an effective solution for managing water resources through automation. It enables accurate monitoring and control across various sectors, including residential, agricultural, and industrial applications. At the heart of this system is the JNSSR04T ultrasonic sensor, which measures the distance from the water surface to the sensor, ensuring continuous tracking of water levels without hassle. When water is close to the detection point of the sensor, which is only 3 cm from the sensing point, the system stops the water pump immediately to prevent overflow disasters.**

***Index Terms*—Water Overflow Prevention, Sensor-Based Control Systems, JNSSR04T Sensor, Ultrasonic Sensor, Water Level Monitoring, Pump Control System, Real-Time Water Tracking, Remote Monitoring.**

I. INTRODUCTION

In the twenty-first century, water scarcity is one of the major problems facing the world. Estimates by the UN show that approximately 2 billion people live in countries facing severe water stress. Over-withdrawal of water leads to scarcity, though it is bad management, pollution, and chaotic climate change weather disturbances that aggravate this problem. Many regions, especially those in developing countries, often mismanage their water resources and result in considerable waste and inefficiency.

The waste impacts millions of lives, industries, and agriculture consuming more than 70% of the world's freshwater. Therefore, the need for smarter and more sustainable water management solutions is mounting. As the Internet of Things (IoT) starts to transform the water management system, more effective solutions are on the horizon. IoT allows real-time data collection and analysis, automates water processes relating to its monitoring, management, and optimization, thereby enhancing the reallocation of resources, waste reduction, and informed decision-making.

One is IoT-based water monitoring system for automatic pump operation, a system that incorporates cloud computing and IoT sensors to counter problems related to water management. It applies to use in industrial water systems, agricultural reservoirs, and home water tanks, both facilitating remote control and immediate monitoring, which means that human intervention is reduced to nil and ensures no overflow and efficient consumption of water.

Overview of the System

The IoT-based water monitoring system for automatic pump operation is the modern way of controlling the levels found in reservoirs or storage tanks. With several hardware and software parts, the said system will give an accurate, real-time data for the water levels while it is automatically managing water. The system relies on some critical elements that work together to fulfill its water management objectives. The other components of the system include the JNS-SR04T Ultrasonic Sensor.

II. LITERATURE SURVEY

Increasing demands on sustainable water resource management have catalyzed the advent of IoT-based water level monitoring systems. The results obtained from literature surveys revealed that the implementation of IoT technology improved real-time data collection and analysis, thereby making improvements in control and decision-making in water management systems.

Current applicability and solutions: Several research works have been carried out regarding an IoT-based monitoring system employing sensors to monitor applications in agriculture, flood management, and reservoir level control. These systems effectively minimize water waste and improve resource distribution.

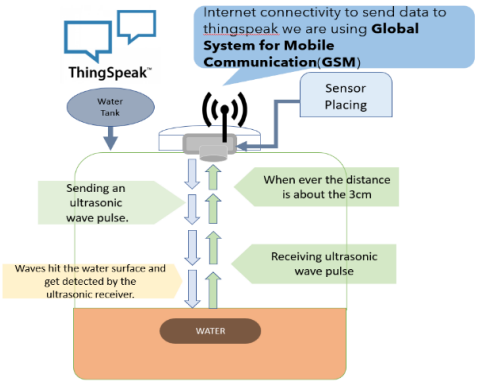
Principle and Reliability of Ultrasonic Sensors in Measuring Water Level: The adoption of ultrasonic sensors in measuring water levels is overwhelmingly accepted primarily due to their cost-effectiveness,

easy installation, and lack of contact. From various studies, most of them show that these sensors are relatively reliable under multiple environmental conditions except for sometimes being affected by the influence of temperature and humidity factors.

Applications of Intelligence Water Monitoring: Some studies have utilized ultrasonic sensors in water management systems. For instance, [Author C, Year] talked about a system that utilized ultrasonic sensors for the real-time water level assessment. The performance shall also be highly reliable in measuring water levels in tanks in urban areas.

III. METHODOLOGY

This IoT-based water monitoring system for automatic pump operation is therefore a control of a pump according to the water levels in a tank through monitoring of them. The main components thus comprise the GSM 800L module for data sending and the JNS-SR04T ultrasonic sensor that provides distance measurement in relation to the water surface. The aim is that there will never be any overflows because the pump would turn off the water automatically once it reached a certain level.



The second feature, the remote monitoring and control, will be availed through a cloud-based platform that is called ThingSpeak. In this case, hardware setting-up presents the first stage. Hardware setup is the first step of the process. To measure the water level, an ultrasonic sensor is mounted above the tank, and the ESP32 microcontroller interprets the sensor's output. The microcontroller enables IoT functions such as data transfer and equips the device with processing power it requires. In addition, the system is equipped with a relay module that uses the sensor data to control the water pump.

The ultrasonic sensor is always sensing the water level as part of the detection and control logic. The ESP32 sends a signal to the relay to cut off the pump in case the sensor is reading the water level to be within 3 cm to the top of the tank for prevention of overflow. The

water level, once it drops to a certain level (for example, 20cm), will cause the pump to activate and refill the tank back to its ideal water level. The GSM 800L module allows the data from the water level to be transmitted to ThingSpeak where the communication and integration into the cloud are performed. Data storage and presentation is also performed using cloud platform ThingSpeak, which provides users with the real time water level. Several steps are conducted in the testing phase to ensure that the system is reliable and 4. The JNS-SR04T ultrasonic sensor's precision in the measurement of distances is tested through preliminary hardware testing, of which the setting is at different water levels and against a calibrated measuring tape. Moreover, the relay modules.

Confirmation: there is a capability to correctly ON/OFF the pump through switching in response to commands from the ESP32 microcontroller. All the system components are then assembled together and tested with integration. It watches over the communication of the ESP32, ultrasonic sensor, relay, and GSM module. This stage confirms that data moves across the system without hiccups.

IV. IMPLEMENTATION

The first step in putting the IoT-Based Water Monitoring and Pump Control System into practice is putting together the hardware, which includes the GSM 800L module, ESP32 microcontroller, JNS-SR04T ultrasonic sensor, and a relay module for controlling the water pump. The distance between the JNS-SR04T sensor and the water's surface is measured by mounting it above the tank. Based on the water levels observed, the ESP32 microcontroller, which acts as the central processing unit of the system, reading information from the ultrasonic sensor and controls the pump through the use of the relay.

The distance read by the ESP32 is programmed to interpret the reading from the ultrasonic sensor. Distance readings that fall within 3 cm of the top prove the water level is high, and distances lower than a predefined boundary, such as 20 cm, imply that Logic. Now, the relay module gets the right signals

from the ESP32, and thus it decides to turn on the motor when the level of water is low and made it turn it off when it's high. This reason can automate the management of water, and so, the involvement of humans is not required. The GSM 800L module is used for data transfer in the linking of the ESP32 and sending the data about water level to ThingSpeak-a cloud platform for data display and storage. The real time monitoring of all data on the dashboard of the ThingSpeak platform offers past data for study, and be notified when key thresholds are crossed. The user can also manually operate the water pump by means of the ThingSpeak interface, so the user has full flexibility and choice of the amount of water used. Testing is very important to ensure the system performs as required. Testing for Accurate Measurements and Relay operation, each piece of hardware is first checked independently. After passing component verification, the system is tested for smooth data transfer and communication among ESP32, ultrasonic sensor, relay, and GSM module during integration testing. Functional tests are performed for emulating different the water levels in the tank, which are proven to be accurate since the pump cuts off at high water levels and is on at low ones in keeping with the set predetermined criteria. Lastly, the ThingSpeak platform tests the remote capabilities of the system so as to ensure accurate data presentation, real time monitoring and response to user inputs.

V. HARDWARE COMPONENTS

A. ULTRASONIC SENSOR(JSN-SR04)

The sonar concept is used by an ultrasonic sensor. Through a transmitter, it sends out ultrasonic waves, which are then picked up by a receiver after bouncing off an object.

The distance may be calculated using the speed of sound and the time it takes for the waves to reach and return to the item.

This formula is used to calculate the distance:
Distance = (sound speed × flight time)/2

B. MOTOR PUMP

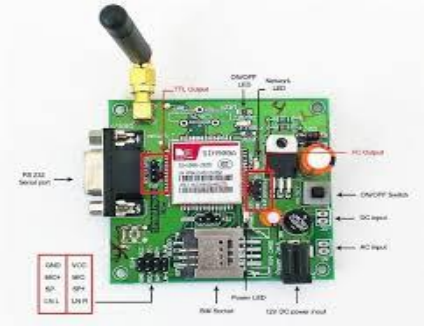
Compact and energy-efficient, DC motor pumps use direct current (DC) power at 3 to 6 volts. Suitable for battery-powered or portable applications such as aquariums, hydroponics, car systems, and small-scale water management jobs, they are very lightweight and compact in design. They conserve energy for battery-operated systems because they consume less electricity than AC pumps. These pumps have long-lasting durability, do not corrode these materials, and easily interact with microcontrollers for accurate automation in a range of applications.

C. ESP32 MICROCONTROLLER

The ESP32 microcontroller was developed by Espresso Systems and is a rather a popular and powerful tool for IoT applications and low-priced built-in Wi-Fi and Bluetooth connection. It is centered around the dual-core Ten silica Extensa LX6 CPU, that mainly provides much processing capacity for a number of complex applications. Because of many advantages, this microcontroller It can be used for a range of applications that have demands for wireless connectivity, efficient processing, and low power consumption. The features of ESP32 include: CPU with Two Cores: ESP32 is equipped with a dual-core Xtensa LX6 CPU operating at speeds of up to 240 MHz This provides it with substantial processing power for applications that need a lot of computing due to its

configuration that enables it to process even the most complex tasks efficiently.

D. GSM 800L MODULE



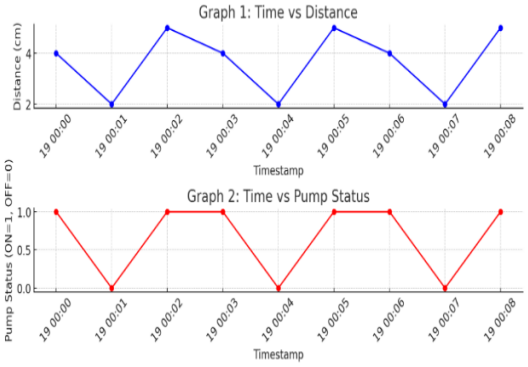
An electronic device can communicate via cellular networks by means of a GSM (Global System for Mobile Communications) module, a small device that acts similarly to a mobile phone within the device. This lets the device transmit data, make phone calls, and send and receive SMS messages. Devices may be connected to the GSM network by embedding a GSM module, which is necessary for remote communication and Internet of Things applications including home automation systems, smart meters, and vehicle tracking. The module is perfect for wireless, long-distance communication since it accesses the network via a SIM card, just like a phone does.

VI. RESULT

The IoT-based water monitoring system for automatic pump operation has been developed with the goal of automating water level maintenance within a specified range. This system is built using key components, including the ESP32 microcontroller, the JSN-SR04T ultrasonic sensor, the GSM 800L module, and a 3-6V pump. Its primary function is to monitor water levels in real time, leveraging the ultrasonic sensor to gauge the distance to the surface of the water.

The ESP32 serves as the system's central processing unit, collecting data from the ultrasonic sensor, processing it, and determining the current water level in the tank. The ultrasonic sensor employs a trigger and echo mechanism, measuring the time it takes for an ultrasonic pulse to return after bouncing off the water surface, which allows the system to accurately calculate the distance to the water. This data is continually processed to ascertain the actual water level in the tank.

Another vital feature is the GSM 800L module, which provides real-time updates via SMS notifications. If the water level reaches a critical low point, the system will send a message to notify the user about the pump's actions and overall system status. This feature is particularly beneficial for applications where the user needs to stay informed about water levels, especially in remote or automated setups.



Additionally, the system includes an LCD display that continuously shows the current water level, allowing anyone nearby to verify the status without needing a computer or smartphone. The entire system operates on a loop, with the ESP32 microcontroller measuring the distance using the ultrasonic sensor at regular intervals. If the water level falls too low, the pump is automatically triggered to refill the tank. Once the tank is sufficiently filled, the relay cuts off the pump to avoid any overflow.

Through testing, the system has demonstrated consistent performance, delivering accurate distance readings and reliable pump control. The GSM module effectively sends alerts each time the water level reaches a critical threshold, whether during refilling or when the levels are too low.

VII. CONCLUSION

The IoT-based water monitoring system for automatic pump operation provides a clever, automated answer to the pressing demand for efficient water management. In order to prevent tank overflows and to maximize the use of the pump, it utilizes an ESP32 microcontroller, an ultrasonic JSN-SR04T sensor, and a GSM module to offer live, real-time monitoring of water levels. It enables consumers to monitor remotely the water levels through its ability to transmit data to the ThingSpeak platform.

Additionally, when water levels become harmful, GSM-based SMS alert offers an accurate report, even in locations where access to Wi-Fi might be constrained. The strategy chosen here is very elastic and can be adapted in a It is present in a variety of

settings where water resource conservation is critical, such as homes, farms, and industrial settings. This answer, that emphasizes affordability and ease of use, promotes efficient use of water and minimizes waste in support of sustainable water management. Future innovations will likely enhance its ability to forecast water requirements based on usage trends and interface with additional IoT-based devices, establishing it as a crucial component of astute, environmentally responsible resource management programs. This strategy is quite flexible and can be used in a variety of settings where resource conservation is essential, such as homes, farms, and industrial settings. This solution, which focuses on affordability and ease of use, encourages effective water use and waste reduction, giving support to sustainable water practices. In the future, it could amplify it's to make water requirement forecasts as per the usage trend and to interact with other IoT-based devices hence making it an integral part of wise, responsible resource management programs.

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