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Smart Roof Top Water Management System

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Abstract

In this study, we present a novel approach to the problem of growing water shortage, which is a critical resource that is running out in many parts of the world. Our system is based on the combination of a microcontroller and an ultrasonic sensor, which monitor the water level in a rooftop water tank and notify users in a timely manner when needed. Our system has an innovative feature that goes beyond monitoring and alerting: it can automatically manage the flow of water from the motor to the tank, removing the need for human interaction throughout the tank-filling process. We have also added a feature to our system that allows users to report on their water usage. This part collects, records, and analyses water consumption data continually to give users detailed reports on their usage habits. Our goal is to encourage more responsible and effective practices for managing water resources by providing users with access to these comprehensive reports. In conclusion, our system provides a comprehensive approach to water management that not only protects a valuable resource but also gives users the vital information they need to make wise decisions about how much water they use.

Keyword: Microcontroller & Ultrasonics sensor

Introduction

Advanced water storage systems known as "smart water tanks" make effective use of sensors and actuators to control and monitor the water supply. These tanks' real-time water level data capabilities enable users to maximise water efficiency and prevent water waste.[3] .With the rise in IOT (Internet of Things) and other cutting-edge technology in daily life, the idea of smart water tanks is relatively new and has gained popularity in recent years[1]. These days, smart water tank systems are widely utilised in a variety of settings, including business structures, residential dwellings, and agricultural settings. Large volumes of water are also managed and stored by them in industry.This study examines how smart water tanks may be used to detect water levels using sensors, connect with an Arduino Uno microcontroller, and operate LEDs that illuminate at different water levels in the tank. The goal is to increase the efficiency of water monitoring and flow. The advantages and difficulties of smart water tanks are also covered in the study, along with their uses in residential, commercial, and agricultural settings.

The structure of the paper is as follows. After giving a general overview of smart rooftop water tank technology and going over its parts and operations, it discusses how sensors and microcontrollers are used in smart tanks, going over the ultrasonic sensor and the Arduino Uno microcontroller in particular. Finally, it looks at the advantages and disadvantages of smart rooftop water tanks, including cost and energy savings. The discussion then shifts to possible usage for smart water tanks in residential, business, and agricultural settings. Lastly, it offers a conclusion and explores potential future research and development paths for smart tanks. It is obvious that smart water tanks have the power to change our living environments and raise our standard of living as they develop further. However, resolving the issues related to cost, security, and interoperability is crucial to maximising the potential of smart tanks.

Research background

Components of Smart Water Tanks

A number of parts make up smart water tanks, such as communication technology, control systems, and sensors. A smart water tank system's key components include an ultrasonic sensor that measures the tank's water level and transmits the information to the control unit; a control unit that automates the water flow and notifies the user in the event of a water shortage; a pump that is connected to a microcontroller and can be turned on and off as needed; and a connectivity module that allows for internet or GPRS connectivity, enabling remote monitoring and control.

Challenges of Smart Water Tanks

Although smart water tanks have many advantages, there are certain drawbacks as well. Some of them include: The precision and dependability of the sensor has a significant impact on the water flow through the pump, perhaps leading to overflows. Another problem that could disable the control unit and alter the flow of water is a lack of power. Another problem that could arise during remote monitoring and control is connectivity, which could prevent the user from receiving accurate water level data. On the other hand, prolonged use of these programmes may result in overheating.

Functions of smart roof top water monitoring systems

Systems with smart water tanks include a number of features that can improve user satisfaction and conserve water. Water storage, water level and usage monitoring, automated filling, remote monitoring and management, and energy efficiency are a few examples of these features. Water storage makes it possible to store water effectively. Water level monitoring sends information about the water level to the microcontroller. Automatic filling involves connecting the motor to the microcontroller so that the tank is filled automatically.

Benefits of Smart Water Tanks

Smart water tanks provide many advantages, such as increased user satisfaction, less water waste, increased energy efficiency, and the ability to turn a motor on and off without the need for human intervention. This reduces the massive volumes of water that are wasted as a result of water tanks overflowing. Additionally, it saves energy by only turning the engine on and off when necessary.

Potential Applications of Smart Water Tanks

Applications for smart water tanks could be found in a variety of settings, including commercial structures, residential residences, and agricultural settings. Smart water tanks might be helpful in residential settings to automate the filling process because, in large-scale installations, it may be challenging to manually regulate the flow and any error could result in an overflow of water. In the agricultural industry, it could be helpful to farmers who find it difficult to manually monitor the flow of water in different locations. Automation of this procedure is required in commercial buildings since a malfunction in the water flow there can cause significant losses.

The Present Study

The current study does not go into great detail about the monitoring component of smart rooftop water management systems; instead, it focuses primarily on the water quality assessment within rooftop water tanks using a more conventional system with limited integration from the IoT (Internet of Things) sector. In addition, a crucial aspect of the present investigation is the thorough examination of patterns of water consumption. This aspect of the study focuses on tracking and documenting water usage statistics, giving users in sightful knowledge about how they use water. Our goal in concentrating on this water usage report is to improve knowledge of consumption patterns and encourage more effective and sustainable water management.

There aren't many research that we're aware of that look into using smart roof top water monitoring devices to find leaks. Research on the use of smart roof-top water monitoring systems has been conducted, but not much on the use of IOT to automate the pumping system while monitoring the tank's water level. By investigating the possibilities of smart roof-top water monitoring systems for the aforementioned condition and integrating them with the current system, our study seeks to close this gap and provide a better overall framework. Through showcasing the viability and efficiency of employing intelligent rooftop water monitoring devices, our aim is to stimulate additional investigation and advancement in this domain. Furthermore, the commercial, agricultural, and residential sectors may benefit practically from our study. We will give a thorough explanation of our study's methodology in the next section, together with information on the tools and supplies utilised, the layout of the experiment, and the methods for data analysis.

Procedure

Prior to updating the code to our preferences, we must first connect the hardware in accordance with our specifications. The ultrasonic sensor and Arduino must first be connected in order to verify that the distance is being measured accurately. Next, we attempt to connect the motor to the Arduino independently and operate it in various scenarios using the motor driver integrated circuit. Next, we combine the first two components and do more testing. During the integrated part test, the motor needs to pump water based on the code-given parameters and the ultrasonic sensor's reading. Lastly, we incorporate the LED into the image.In accordance with the three phases of the water pumping process, we will add three LEDs. Each will blink in accordance with the current stage. We now get a preview of the model's appearance. After that, we have to thoroughly test the fully integrated system to look for any potential minor problems.

Methods

Materials

The following materials were used in the study: Ultrasonic sensor
5V Submersible Motor
Motor driver IC
Arduino Uno
Arduino
USB cable
LED
Resistors Jumper wires
Breadboard
9V Battery
Dummy Tank
Dummy Reservoir

Hardware Setup

With the use of jumper wires and a breadboard, the Arduino Uno board was connected to the ultrasonic sensor, 5V submersible motor, 9V battery, and motor driver IC. Using a breadboard and an additional pair of jumper wires, the LED was also attached to the board.

Software Setup

The code was uploaded to the Arduino Uno board using the Arduino IDE. The C code had functions for reading the measured distance and regulating the LED in response to the readings.

LED Control

The LED was connected to the Arduino Uno board and was controlled by the code that was uploaded to the board. The code was designed in such a way that it would blink based on the three stages defined in the code.

We will connect the LEDs and specify the voltage needed to alter the colours using analogWrite. A specific led will blink if the tank's empty level is more than 10 cm. In a similar vein, the second led will flash if the level is between 6 and 10 cm. Lastly, the last led will flash and the motor will also stop if the level is less than or equal to 3 cm. When the model is put to the test, the transition between the leds is clearly visible.

3. Proposed Architecture

The ultrasonic sensor, 5V submersible pump, motor driver IC, three LEDs, resistors, breadboard, dummy tank, dummy reservoir, and jumper wires are all part of the suggested architecture for the smart roof-top water monitoring system. These parts are coupled with an Arduino Uno microprocessor, which interprets the information and selects the proper LED colour according to the water level[4].

The water level in the tank is determined by the ultrasonic sensor. The tank stands about 16 centimetres tall. We divided the height computation into three steps so that the LEDs could be incorporated into the programme. The water level is divided into two sections: the first occurs when it is greater than or equal to 13 cm (from the top of the tank), and the second occurs when it is between 6 and 10 cm. The water level less than or equal to three centimetres (from the top of the tank) is indicated in the final section.We incorporated the feature to calculate and report water usage for the report on water usage.

Our device can determine how much water is used over time by tracking the water level continuously. With the use of this information, we can create a thorough report on water usage that highlights trends in consumption. Furthermore, we can modify the LED colours to match particular water level ranges by using the analog write function.

The submersible pump is activated by an Arduino command sent to the motor driver IC if the tank is empty to a depth of 13 cm or more[7]. The pump keeps pumping water into the tank until the water level is around 3 centimetres (or less) below the top of the tank, at which point it stops. A different LED lights at every step, visually representing the criteria we have set (this is merely for demonstration purposes). All things considered, the suggested architecture for the smart roof-top water monitoring system offers a straightforward but efficient means of cutting down on overspill or water waste while pumping on a big scale.

Conclusion

To sum up, this model offers only a cursory overview of water conservation. One useful tool for managing and conserving water resources is an intelligent rooftop water monitoring system. The model was made easier to understand by using an LED for visual representation and an Arduino Uno microcontroller for complete integration. We can minimise water waste and maximise water utilisation by detecting and monitoring the water level in the tank.

This specific application may find use in the commercial, residential, and agricultural domains.
The application of this technology can lower water bills, protect water supplies, and support environmentally friendly methods of managing water resources. Users of the system will be able to access web interfaces and mobile applications through their integration. real-time data, remotely control water usage, and provide alerts[2][8]. The real-time water consumption data provided by this system, which makes use of IoT-based technologies including sensors, wireless connection, and cloud computing, can help users make wise and efficient decisions regarding their water usage.

All things considered, this study lays the groundwork for further research in this field and highlights the potential of smart roof top water monitoring devices. The demand for water is rising along with the population every day, leading to an increasing scarcity of water.

Thus, it is imperative to implement smart rooftop water monitoring systems to guarantee responsible and effective water use. If properly applied, this technology can drastically change how water is managed and pave the road for a more sustainable future through widespread adoption

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