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AUTOMATED WATER CONSERVATION AND MANAGEMENT SYSTEM

ABSTRACT

This study presents a novel water detection and management system designed for polytank water storage in Ghanaian households. The system integrates an ultrasonic water sensor with an Arduino Uno microcontroller to automate water supply, with the capability to cut off when the tank reaches its capacity. Complemented by a buzzer and LED indication system and an innovative cleaning subsystem, the design addresses the challenges of water overflow and wastage. Through detailed exploration of design, implementation, and testing, this research highlights the system's potential to enhance water management and contribute to sustainability.

INTRODUCTION

In the evolving landscape of modern society, access to clean and reliable water remains a fundamental necessity. In Ghana, the fabric of societal development is tightly interwoven with the provision and management of water resources. Today, a significant advancement can be observed in the domestic water delivery systems across Ghanaian households, where almost every home is equipped with an effective water delivery mechanism. A prevalent practice involves the storage of water in polytanks, which are designed to hold a specified capacity of water. While this system has undoubtedly enhanced the convenience of water storage and access, it is not without its challenges. One of the primary concerns associated with this method is the potential for water overflow, which can lead to wastage, property damage, and environmental repercussions. Addressing this issue necessitates innovative solutions that not only detect the water level accurately but also offer practical and efficient interventions to manage and utilize water effectively. This research paper delves into the development and implementation of a water detection system tailored to the specific needs of Ghanaian households, aiming to mitigate the challenges associated with water overflow and contribute to sustainable water management practices in real-life situations.

LITERATURE REVIEW

Efficient water management is essential for addressing global water scarcity concerns. While various methods have been developed to control water pumping machines and indicate water levels, certain drawbacks exist due to the sensing methods employed.

Ishwar and Yadav (2013) constructed an experimental setup incorporating metallic contact sensors to control a motor pump. This system switches the pump ON when the overhead tank is nearing depletion and OFF when it is about to overflow. While effective, this method relies on direct contact with water, which may lead to sensor degradation over time.

Jain (2015) proposed a model for water pump control using radio transmitters and Wi-Fi routers. This wireless approach offers flexibility and convenience but may be limited by signal interference and connectivity issues.

Oghogho and Azubuike (2014) developed an experimental setup with metallic contact probes and analog-to-digital converters (ADCs) to monitor water levels. This system eliminates the need for direct contact with water but may be complex to calibrate and maintain.

While these systems offer various benefits, they also present challenges such as sensor calibration and maintenance. Additionally, ensuring compatibility and reliability in diverse environmental conditions is crucial for the widespread adoption of automatic water shut-off systems utilizing water sensors.

In contrast, a novel approach involves the utilization of water sensors for automatic water shut-off systems in water tanks. This system incorporates a water sensor positioned at the top of the water tank to detect the water level. When the water level reaches a predetermined threshold, the water sensor sends a signal to a microcontroller, triggering the shut-off mechanism to stop the water supply.

Furthermore, this system introduced an indication system comprising a buzzer and LED to signify when the water tank is full. Once the water sensor detects that the water level has reached the maximum capacity, the microcontroller activates the buzzer and LED, providing both visual and auditory cues to indicate that the water tank is full and the water supply has been automatically shut off. This system also introduced a sub-system for cleaning utilizing a shaft with connected arms with brushes.

Ultimately, automatic water shut-off systems utilizing water sensors offer a promising solution for efficient water level control in water tank systems. By leveraging advancements in sensor technology and control mechanisms, these systems provide a reliable means of preventing overfilling and promoting sustainable water management practices.

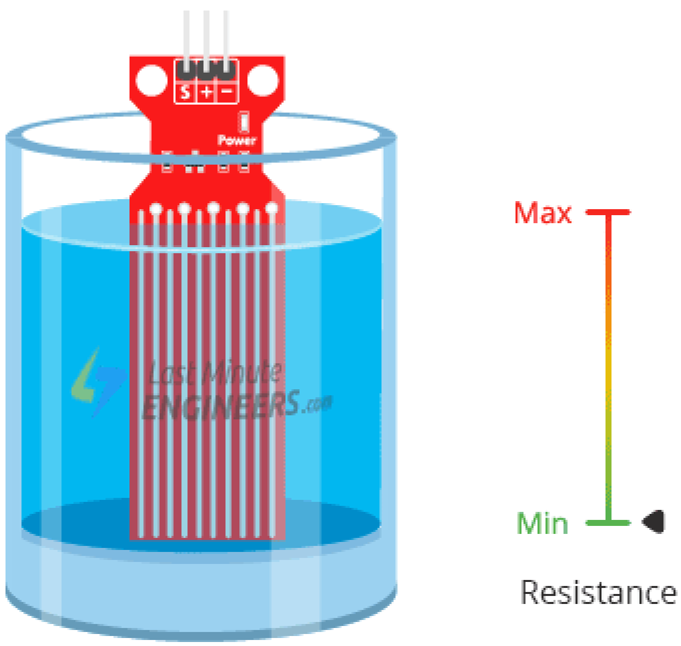
SYSTEM DESIGN

The automatic water shut-off system utilizes various components to detect water levels within a polytank and cutting off power supply when the tank is full. The system consists of the following components:

1. Water level sensor

The operation of the water level sensor is fairly simple.

The power and sense traces form a variable resistor (much like a potentiometer) whose resistance varies based on how much they are exposed to water.



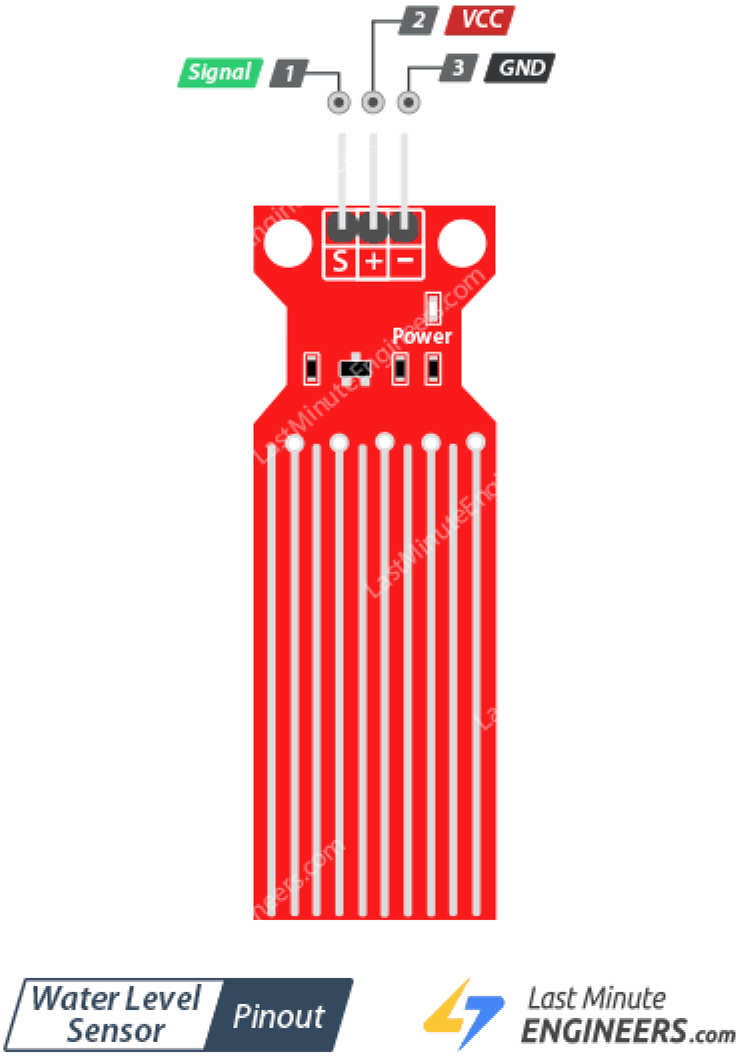
This resistance varies inversely with the depth of immersion of the sensor in water:

- The more water the sensor is immersed in, the better the conductivity and the lower the resistance.
- The less water the sensor is immersed in, the poorer the conductivity and the higher the resistance.

The sensor generates an output voltage proportional to the resistance; by measuring this voltage, the water level can be determined.

Water Level Sensor Pinout

The water level sensor is extremely simple to use and only requires three pins to connect.



S (Signal) is an analog output pin that will be connected to one of your Arduino's analog inputs.

+ (VCC) pin provides power to the sensor. It is recommended that the sensor be powered from 3.3V to 5V. Please keep in mind that the analog output will vary depending on the voltage supplied to the sensor.

– (GND) is the ground pin.

2. **Microcontroller (Arduino Uno):** The microcontroller serves as the central processing unit of the system. In this design, an Arduino Uno microcontroller is used to receive input from the ultrasonic water sensor, process the data, and control the operation of the water pump and indication system based on predefined logic.

3. **Water Pump:** The water pump is responsible for supplying water into the polytank. When the water level detected by the ultrasonic sensor reaches a predetermined threshold, the microcontroller sends a signal to activate the water pump, allowing water to flow into the polytank. Once the water level reaches the maximum capacity, the microcontroller deactivates the water pump to prevent overflow.

4. **Indication System:**

- Buzzer: The buzzer provides an auditory signal to indicate when the polytank is full and the water supply has been automatically shut off. It emits a sound when triggered by the microcontroller.

- LED (Light-Emitting Diode): The LED serves as a visual indicator to complement the auditory signal from the buzzer. It illuminates when the polytank is full, providing a visual cue to the user.

5. Resistors and Connecting Wires: Resistors are used in the circuitry to limit current flow and protect components from damage. Connecting wires are used to establish electrical connections between the various components, ensuring proper communication and functionality of the system.

System Operation:

1. The water level sensor continuously gives readings with regard to voltage and resistance based on level of water it is exposed to.

2. The Arduino Uno microcontroller receives data from the water level sensor and compares it to predefined threshold values.

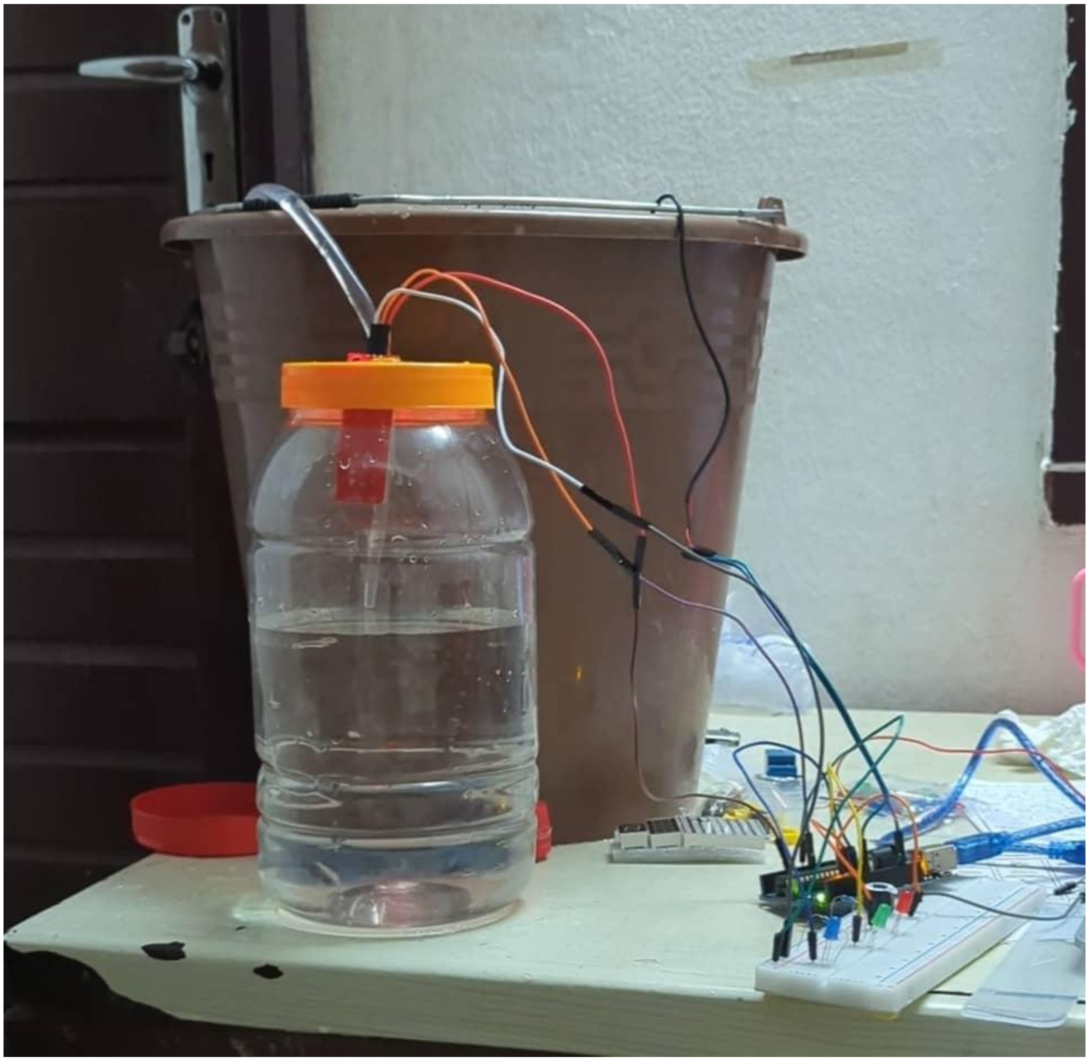
3. If the water level is below the minimum threshold, the microcontroller activates the water pump to start supplying water into the tank.

4. As the water level rises and reaches the maximum threshold, the microcontroller sends signals to deactivate the water pump and trigger the indication system.

5. The buzzer emits an audible signal, and the LED lights up to indicate that the tank is full and the water supply has been automatically shut off.

6. The system remains in standby mode until the water level decreases below the minimum threshold, initiating the next cycle of water supply.

PICTURE OF THE SYSTEM UNDER OPERATION



SYSTEM IMPLEMENTATION

The water level sensor has three pins, the pins labeled S, + and -. The S pin is connected to analogue pin A0. The + pin is connected to 5V, and the – is connected to the ground

The submersible water pump is connected to the digital pin 7, and the ground. There are two LEDs and a buzzer for indication. The positive terminals of the LEDs and the buzzer are connected to digital pins 6, 5, and 4 respectively. The negative terminals are connected to the GND (ground pin).

The pump is submersed in the source and its outlet tube is connected to the top of the tank. The sensor is located at the top of the tank. As soon as the water touches the water level sensor, one LED turns on. The other LED and the buzzer goes off when the water level sensor reads a value greater than 680. The submersible pump automatically turns off.

The motor is on top of the tank and is connected to the 5V and ground (GND) pins. The cleaning shaft is connected to the rotating pin of the motor. The cleaning system may be turned on and off by a push button.

TESTING

The project underwent several tests which ended up in errors. Most of the errors were as a result of insufficient power supply since the sole source of power was from the five (5) volt pin in the microcontroller. Other problems were as a result of the codes not being explicit and conducive to execute commands. The final product exhibited two innovations. The first was cutting the water supply to the tank to prevent overflow. The second innovation was the cleaning system.

CONCLUSION

This research developed an automated water detection and management system tailored for polytank water storage in Ghanaian households. By integrating an ultrasonic water sensor with an Arduino Uno microcontroller, the system automated water supply, cutting off when the tank is full. The addition of a buzzer and LED indication system, coupled with an innovative cleaning subsystem, effectively contributes to the management system.

Despite encountered challenges in testing, the project introduced two significant innovations: automatic water shut-off and an integrated cleaning mechanism. This system presents a practical solution for sustainable water management in domestic settings.

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