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AUTOMATIC CONTROL OF A PUMP SYSTEM FOR WATER LEVEL USING MICROCONTROLLER

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ABSTRACT

Water scarcity is a significant challenge faced by numerous cities worldwide, and the excessive wastage of water during transmission has been identified as a primary contributor. This serves as a key motivation for the current study, which seeks to employ computing techniques to establish a barrier against wastage. The primary goal is not only to yield financial benefits and energy savings but also to contribute to environmental conservation and the preservation of the water cycle. Ultimately, this endeavor aims to secure our water resources for future generations. The study at hand revolves around the implementation of an automatic control system designed to regulate the water level within a storage tank. This innovative system effectively manages the operation of the water pump, activating it when necessary and deactivating it when no longer needed. The core components of this system include a microcontroller and Lab VIEW software, which collaborate to automate the water pumping process in an overhead tank storage system. This advanced system possesses the capability to monitor the water level within the tank, allowing it to seamlessly control the pump's operation by turning it on or off as required. Additionally, the system provides real-time status updates through an LCD screen, ensuring efficient and effective water management.

Key Words: Microcontroller, Labview, Arduino, LINX.

I. INTRODUCTION

Water, as a universal solvent, holds immense significance in our daily lives, serving as a crucial component of numerous everyday activities. While rainwater remains the most accessible water source in many areas, the invention of pipe-borne water in the last century has provided a purified alternative, devoid of harmful microorganisms yet containing essential mineral salts. This purified water source is widely accepted in most countries and commonly used for drinking. However, the world is currently grappling with water scarcity, necessitating prudent management to minimize wastage. In some households, boreholes and wells are equipped with storage tanks to hold water before pumping it into overhead tanks. Typically, individuals activate their water pumps when their tanks run low, indicated by a cessation of water flow from taps, and deactivate them when the tanks are full, preventing overflow. Regrettably, this manual control method often leads to avoidable waste and, at times, water shortages during emergencies. At the household level, individuals occasionally initiate water pumps and then go about their day, sometimes even forgetting to turn off the pump when the tank is full. This negligence results in unnecessary wastage and potential flooding. Traditional pumping machines lack the capability to regulate the volume of liquid they pump, making them susceptible to causing flooding if left unattended for extended periods. To address these challenges, we propose the construction of an experimental setup designed to control water levels in a tank. This control will be achieved through the integration of LabVIEW™ software and a microcontroller. Our system incorporates a float level sensor for liquid level detection, coupled with LabVIEW software running on a Windows-based PC. The automatic water pump controller encompasses a series of functions designed to manage the circuit in a reservoir or water storage system. The water level sensor consists of a metal plate positioned within the reservoir or water tank, featuring a short sensor for detecting the upper level and a long sensor for the lower level. Both sensors are connected to the bottom of the tank, ensuring accuracy. In everyday life, certain physical elements require control to perform as expected. A control system, therefore, serves as a device or set of devices that govern, direct, or regulate the behavior of other devices or systems. In this context, automatic control minimizes or eliminates the need for human intervention. Intelligent systems have found application in various fields, ranging from medical and financial sciences to education and law, embedded within everyday devices. This project represents our effort to embed a control system within an automatic water pump controller, motivated by the pressing issue of water scarcity exacerbated by wasteful water pumping and distribution into overhead tanks. We believe that curtailing wastage will not only yield financial

II. RELATED WORKS

Several researchers have constructed experimental setups to address water management issues. Each setup employs various components and techniques to monitor and control water levels effectively. Here is a summary of their findings:

Ishwar Chanra Murmu and Laloo Kumar Yadav:

They developed an experimental setup with a motor pump that activates when the overhead tank is about to run dry and switches off when it's about to overflow. Metallic contact sensors are used to detect water contact, completing a circuit and generating a signal. A NAND gate is employed in the logic circuit. This system proves beneficial for both rural and urban areas, promoting efficient water resource utilization.

Oghogho Ikponmwosa and Azubuike Charles:

Their setup includes five metallic contact probes with the lowest probe connected to a 5V source as a reference voltage. The other probes serve as inverting inputs to comparators and are used to monitor water level by detecting conductivity. This information is converted into digital signals, activating visual display LEDs. The system eliminates the need for manual pump control, improving efficiency and pump lifespan.

P**raseed Kumar, Shamim S Pathan, et al.:**

Their experimental setup features a water tank receiving water from a reservoir, controlled by a solenoid valve and monitored using a float sensor. The sensor sends a voltage signal to an NI DAQ 9234 input module, which converts it to digital data. A PID controller in LabVIEW software processes this data and sends a 5V signal to a relay-actuated solenoid valve. This system successfully interfaces hardware with LabVIEW software, facilitating automatic water level control.

Ejiofor Virginia Ebere and Oladipo Onaolapo Francisca:

They employed a microcontroller to automate water pumping in an overhead tank storage system. The system detects water levels using copper conductors as sensors. These sensors transmit voltage to a comparator circuit when they come into contact with water. An LM324 comparator compares inputs from the electrodes and outputs HIGH or LOW signals accordingly. The system efficiently controls water levels and improves safety by using DC power.

Md. Moyeed Abrar and Rajendra.R.Patil:

Their automatic water level controller relies on electrical probes inserted into the tank. As water levels change, the probes detect these variations and control a motor pump accordingly. Water sensors sense low and high water levels, controlling the motor. Researchers commonly use comparators and NAND gates in such systems to monitor water levels. These innovative setups aim to enhance water level control, reduce wastage, and automate the pumping process, offering potential solutions to water management challenges. To design and develop a control system for automatic water level maintenance, a comprehensive review of existing literature and previous research by other scholars was conducted. Based on this, a preliminary design was formulated. This description outlines the fundamental block diagram and operation of the entire setup, along with a list of necessary components.

III. EXPERIMENTAL SETUP AND BLOCK DIAGRAM OF THE CONTROL SYSTEM

Figure 1 illustrates the block diagram of the control system designed for automatic pump control to maintain water levels in the tank. When the water level in the tank drops to the lower threshold, it triggers a float sensor, generating a voltage signal. This signal is amplified appropriately and then transmitted to either the Arduino Uno microcontroller or the LabVIEWTM software. Additionally, an ultrasonic sensor is positioned at the top of the tank, connected to the Arduino Uno microcontroller or LabVIEWTM software. When the water level reaches the upper limit, the output from both the ultrasonic sensor and the lower float sensor is relayed to the Arduino Uno Microcontroller and LabVIEWTM software, resulting in the pump's deactivation. The output from the ultrasonic sensor is also displayed on an LED display unit, indicating the water level in the main tank.

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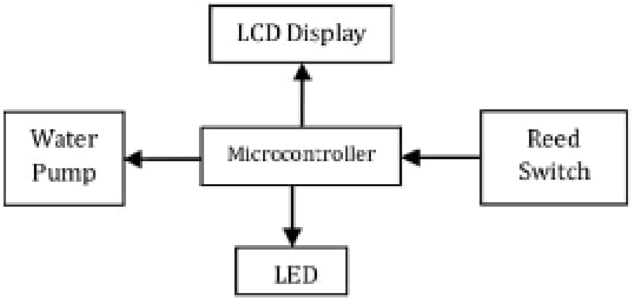

Fig.1 Block Diagram of the project

Control System Design:

The control system is engineered for the pump and various electronic components such as float sensors and ultrasonic sensors. It requires an interfacing device to facilitate communication across a common platform, which is fulfilled by LabVIEWTM and the Arduino Uno microcontroller. Initially, pump control is achieved through the Arduino Uno microcontroller, and subsequently, LabVIEWTM software is utilized.In the experimental setup, two tanks are employed: a storage tank for water storage and a main tank equipped with one float level sensor and one ultrasonic sensor. The pump system receives input from either the Arduino Uno microcontroller or LabVIEWTM software and operates to pump water as needed. When the water level in the main tank falls below the lower float sensor, the sensor sends a voltage signal to the Arduino Uno microcontroller or LabVIEWTM software, depending on the configuration. The respective program then triggers the pump system to transfer water from the storage tank to the main tank. Conversely, when the water level reaches the predetermined upper threshold, a signal is relayed to the Arduino Uno microcontroller or LabVIEW software, causing the pump to stop. If the water level subsequently falls to the predetermined minimum level, the pump restarts to replenish the main tank.

Components in the Experimental Setup:

The following components are essential for the construction of the setup, each with its description:

1.Pump and Adjacent Piping System

2.Level Sensors

3.Ultrasonic Sensor

4.Arduino Uno Microcontroller

5.LabVIEWTM Software

6.Tank

These components collectively form the basis of the control system designed to maintain water levels automatically in the tank.

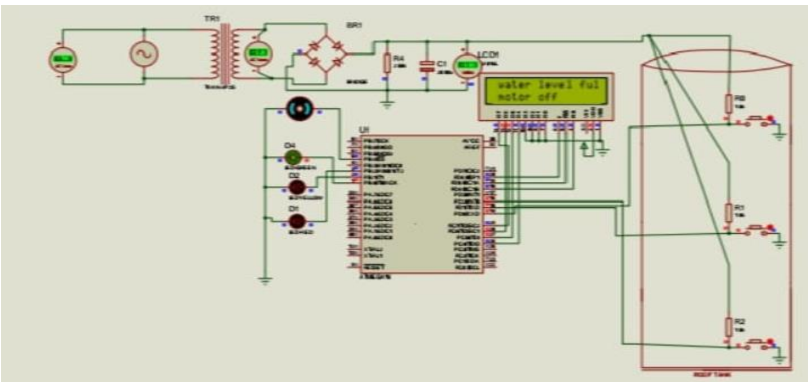

Fig.2. Schemetic diagram of the circtuit

Fig 2. Simulation in Lab VIEWTM using LINX interface demonstrates the LabVIEWTM setup, while Fig 3. Front view of Microcontroller setup and Fig 4. Side view of Microcontroller setup depict the physical arrangement associated with the Arduino Uno setup as given above

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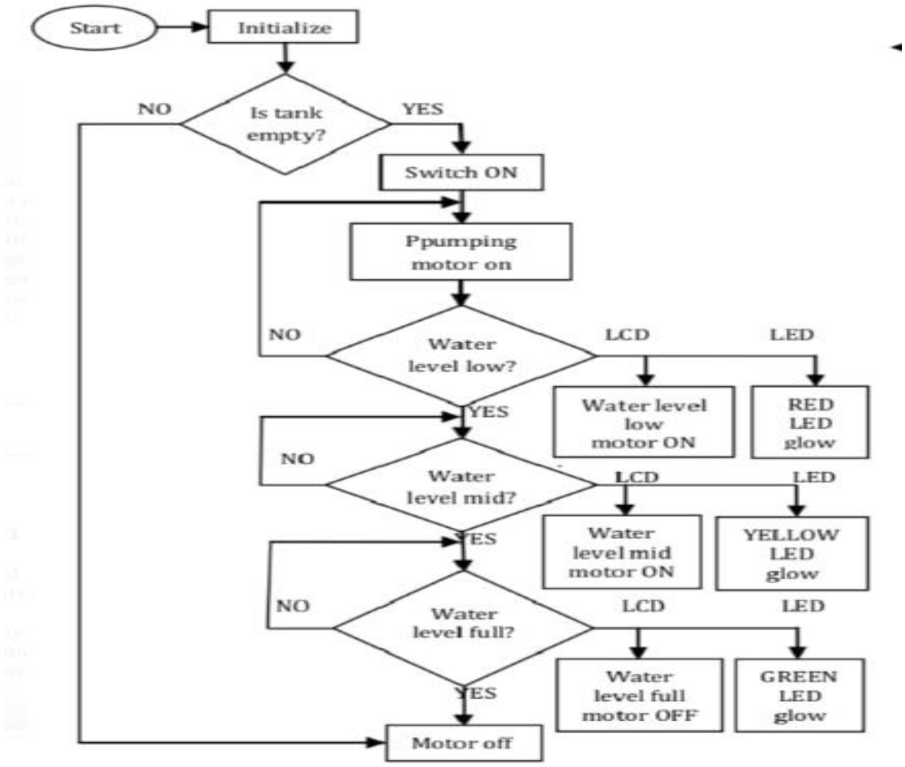
IV. TESTING OF EXPERIMENTAL

SETUP USING LABVIEW AND

MICROCONTROLLER

As illustrated earlier, the control of water level in the tank was accomplished through two distinct methods: utilizing the Arduino Uno Microcontroller and employing LabVIEWTM software. Let's delve into the outcomes achieved using both of these interfacing approaches.



A. Experimental Set-up in Lab VIEWTM:

The experimental setup incorporates various components, commencing with the Ultrasonic sensor. The Ultrasonic sensor is linked to the microcontroller, which transmits the signal to the LabVIEWTM software. The amplified voltage generated by the controller, designed using LINX in LabVIEWTM, is routed to the relay's two terminals. The normally closed terminal of the relay is connected to one end of the pump, while the other end of the pump is linked to the 220V AC mains power supply. The pump's inlet pipe is connected to the water source, and the outlet pipe is connected to the tank. Proper sealing is ensured for both the inlet and outlet pipes to prevent leakage.

B. Experimental Set-up in Arduino Uno:

To achieve the goal of automatic pump control, a microcontroller is considered the optimal solution. Once the microcontroller is programmed, there's no need for further code adjustments. Additionally, as Arduino Uno is open-source hardware, code modifications can be made by individuals with a basic understanding of the C++ programming language, depending on the specific application. The water level in the tank triggers the float, which in turn sends a voltage signal to the Arduino. Based on the pre-written code, the specified terminal in the code provides either a high (5V) or low (0V) signal to the relay. The relay interprets this signal and automatically switches the pump on or off, resulting in immediate pump cutoff.

V. CONCLUSION

The experimental setup for liquid level control has been successfully designed and developed. The system has been effectively designed using the Arduino Uno microcontroller to manage two distinct levels of water. An automatic control system has been introduced to regulate water levels, both low and high, within a tank. A closed-loop control system has been successfully implemented and tested using the LINX interface for Lab VIEWTM.

VI. FUTURE SCOPE

The project on "Automatic Control of a Pump System for Water Level Using Microcontroller" has promising future scope and potential areas of development. Some of the future directions and enhancements for this project could include:

1. Remote Monitoring and Control: Implementing a remote monitoring and control system via the internet or a mobile app. This would allow users to check and adjust water levels in real-time from anywhere, improving convenience and efficiency.

2. Integration with IoT: Expanding the project by integrating it into an Internet of Things (IoT) framework. This would enable the system to be part of a larger smart home or smart building ecosystem.

3. Advanced Sensors: Incorporating advanced sensors for water quality monitoring, leak detection, and water temperature measurement. This would provide a more comprehensive view of the water system.

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