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Automatic control of a pump system for water level using Microcontroller and LabVIEW™

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Abstract - *Water scarcity is one of the major problems facing many cities of the world and wastage during transmission has been identified as a major culprit; this is one of the motivations for this study, to deploy computing techniques in creating a barrier to wastage in order to not only provide more financial gains and energy saving, but also help the environment and water cycle which in turn ensures that we save water for future. The present study involves automatic control system to maintain water level in tank. This system enables to switch ON-OFF pump as per the requirement of water. The system used microcontroller as well as LabVIEW to automate the process of water pumping in an over-head tank storage system and has the ability to detect the level of water in a tank, switch on/off the pump accordingly and display the status on an LCD screen.*

Key Words: **Microcontroller, LabVIEW, Arduino, LINX**

1. INTRODUCTION

Water is a universal solvent which plays an important role in our everyday life. It is used in everyday activities. Rain water is the most accessible source of water in most localities, but in the last century pipe – borne water was invented. This water is free from germs but contains some mineral salts; it is generally accepted in most countries and is used as a source of drinking water. The world is experiencing water shortage, which implies that water source should be managed so as to minimize wastage. In some homes, we will find out that the boreholes and wells have tanks for water storage before pumping up to the overhead tank. People generally switch on their water pump when their tanks are short of water i.e. when the taps stop running and switch off the water pump when the tanks start over flowing. This results in unnecessary wastage and sometimes unavailability of water in cases of emergency.

At the household level, people switch on the water pumps and set off to work or even fall asleep, forgetting to switch off the mains when the tank or reservoir is full. This results to wastage and often flood. The average pumping machine is not in control of the amount of liquid or water it pumps. If the water is left running for over a long period of time without stoppage, it can constitute a form of hazard by flooding the area. Therefore an experimental setup will be constructed to control water level in a tank using LabVIEWTM software as well as microcontroller. In this project we are using float level sensor to sense liquid level along with LabVIEW software in windows based PC. Automatic water pump controller is a series of functions to control the Automatic Water Pump Controller Circuit in a reservoir or water storage. The water level sensor is made with a metal plate mounted on the reservoir or water tank, with a sensor in the short to create the top level and a detection sensor for detecting long again made for the lower level and ground lines connected to the bottom of reservoirs or reservoir.

In everyday life, there must be some physical elements that need to be controlled in order for them to perform their expected behaviors. A control system therefore can be defined as a device, or set of devices, that manages, commands, directs or regulates the behavior of other device(s) or system(s). Consequently, automatic controlling involves designing a control system to function with minimal or no human interference. Intelligent systems are being used in a wide range of fields including from medical sciences to financial sciences, education, law, and so on. Several of them are embedded in the design of everyday devices.

This paper aimed at presenting our project in embedding a control system into an automatic water pump controller. One of the motivations for this research was the need to bring a solution to the problem of water shortage in various places eliminating the major culprit; waste of water during pumping and dispensing into overhead thanks. We believe that creating a barrier to wastage will not only provide more financial gains and energy saving, but will also help the environment and water cycle which in turn ensures that we save water for our future.

2. RELATED WORKS

Ishwar Chanra Murmu, Laloo Kumar Yadav

They have constructed experimental setup which consists of a motor pump which is switched ON when the

overhead tank is about to go dry and switched OFF when the overhead tank is about to overflow. Metallic contacts sensors are used. When water comes in contact with these sensors, the circuit gets completed and signal is generated. This signal is fed to logic circuit to get correct actuator signal. The logic gate used is NAND gate. They have concluded by saying that this system is very beneficial in rural as well as urban areas. It helps in the efficient utilization of available water sources. If used on a large scale, it can provide a major contribution in the conservation of water for us and the future generations.

Oghogho Ikponmwosa and Azubuike Charles

They have setup fabricated experimental setup using five metallic contact probes. The lowest probe in the tank is connected to a 5V source to provide a fixed reference voltage which is conveyed upward along the tank as the water level rises while the other four probes were used as inverting inputs to the various comparators. The ADCs, by utilizing the conductivity of water when ionized because of impurities present in it, are used to monitor the presence of water at the probes and give out corresponding digital outputs. The ADC's are comparators whose outputs at any time depend on the voltage difference between their inverting and non-inverting inputs. The non-inverting (positive inputs) of the ADCs are fixed at a voltage higher than that of the inverting (negative inputs) using a potentiometer. This will set the output logic states of all the comparators in the 1 state. When water level rises and touches the conductor connected to any of the comparator inverting input, it raises the voltage at that inputs such that it becomes greater than the voltage at the non-inverting input thus leading to a change in the output logic state of the Comparator from the 1 state to 0 state. The outputs from the ADCs are used by the microprocessor to give out digital signals which turn on visual display LEDs. The author concludes that the system eliminates the cost and inefficiency of human interference associated with monitoring and controlling the pump while maximizing the performance and life span of the electric water pump.

Praseed Kumar, Shamim S Pathan and et al

The experimental setup consists of a water tank which receives water from a reservoir under a suitable head. A solenoid valve is located at the inlet of the tank. A float sensor located at a suitable height in the tank is used to sense the level of water. The float sensor senses the water level and sends a signal to the NI DAQ 9234 (input module) in the form of voltage. The DAQ card converts this analogue signal into digital signal and sends it to LabVIEW software. The PID controller designed in LabVIEW software will process the data and sends a voltage of 5V as a signal to the output module, i.e. NI DAQ 9263, which will be converting the signal into analogue voltage. This voltage actuates solenoid valve via relay. The author concludes by saying that interfacing of hardware components with LabVIEW software through NI hardware is done successfully. Detection of liquid level by float sensor and corresponding ON/OFF switching of electromagnetic valve is achieved.

Ejiofor Virginia Ebere, Oladipo Onaolapo Francisca

They have used a microcontroller to automate the process of water pumping in an over-head tank storage system and has the ability to detect the level of water in a tank. The pump will switch on/off accordingly and display the status on an LCD screen. The automatic water level monitor used in the study consists of the following major units: sensors, microcontroller, display unit, and the pump and the core work of detecting the level of water is done by the comparator. Taking advantage of the electrical conductivity property of water, the copper conductors are used as the water level sensor. When water touches the copper sensor positioned at a particular level in the tank, voltage is transferred to the copper which in turn is transferred to the comparator circuit for further processing. The LM324 comparator is used to compare the inputs from the electrodes in the tank and with a pre-set resistance and output a HIGH or a LOW with respect to the result from the comparison. The author concludes by saying that this research has successfully provided an improvement on existing water level controllers by its use of calibrated circuit to indicate the water level and use of DC instead of AC power thereby eliminating risk of electrocution.

Md. Moyeed Abrar, Rajendra.R.Patil

The automatic water level controller designed here is on the basis of electro mechanical system using the digital technology. Here, the electrical probes are used along with power supply and motor. The probes will be inserted inside the tank and motor will pump as the water goes down. The probes will detect the level of water and ON/OFF the motor. The level controller used here is the water sensor which will sense the low and high level of water in the water tank. If the water is low, the motor will pump the water and after the high level is reached it will stop to pump water. They have concluded by saying that the automatic water level controller has been successfully designed and developed. Most of the researchers have used comparators for comparing the water level in the tank. Also, some have used NAND gate for comparison of water level. The use of resistors has also been noted in places where two level water control is needed.

3. EXPERIMENTAL SETUP AND BLOCK DIAGRAM

In order to design and develop a control system, the automatic control of a pump for maintaining two levels of water in tank is constructed. The literature review and the work carried out by other researchers is studied. After going through the previous research papers a tentative design is prepared. The basic block diagram and working of the entire

setup is discussed in the subsections below along with the list of components required.

Figure 1 shows the block diagram of the control system for automatic control of the pump for maintaining level of water in tank. When water reaches the lower level in the tank, it actuates the float sensor and a voltage signal is given out as output. Using suitable amplification, this signal is amplified and is fed to the Arduino Uno microcontroller or LabVIEW™ software. Ultrasonic sensor is placed at the top of the tank and connected to Arduino Uno microcontroller or LabVIEW™ software. When the water reaches the upper level, the output of the ultrasonic sensor and lower float sensor is given as input to the Arduino Uno Microcontroller and LabVIEW™ software and the pump is switched off. Output from ultrasonic sensor is fed to the LED display unit and height of the water in the main tank is displayed.

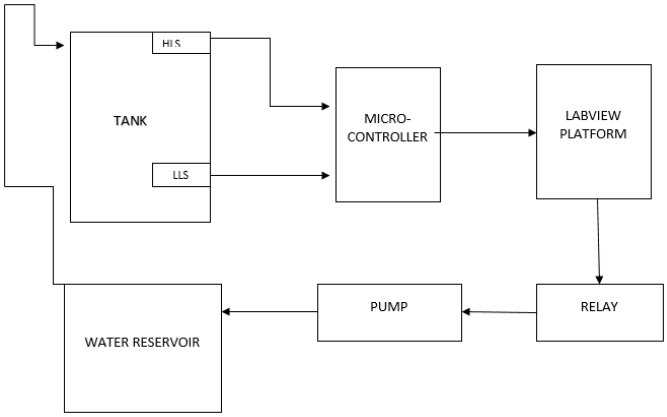

Fig 1. *Block diagram of the control system*

The control system has to be designed for the pump and the electronic devices like float sensors, ultrasonic sensors etc. and require an interfacing device to communicate at a common platform. LabVIEW™ and Arduino Uno play the part of being the interfacing devices. In this system, initially, controlling will be done for switching on/off of the pump system with the help of Arduino Uno microcontroller and later using LabVIEW™ software. In the experimental setup which is designed, there are two tanks i.e. one storage tank which is used for storing water and the main tank will be mounted with one float level sensors and one ultrasonic sensor. The pump system will get its input from Arduino Uno microcontroller in first case and from LabVIEW™ software in the other and its output will be used to pump water when required.

Initially, when the water level in the main tank is below the lower float sensor, the output of the float sensor will be given to Arduino Uno microcontroller or LabVIEW™ software, whichever be the case, in the form of voltage signal. Using Arduino program for microcontroller and LabVIEW™ interface for Arduino, the output is given to switch on the pump system. This will result in water being pumped from the storage tank into the main tank.

Similarly, when water will reach the predetermined upper level of the tank, the signal will be given to the Arduino Uno microcontroller / LabVIEW software and the pump will stop. Again when the water level reaches to the predetermined minimum level, the pump will start pumping water into the main tank.

The following components in the constructional setup. The components along with their description is shown below:

1. Pump and adjacent piping system
2. Level Sensors
3. Ultrasonic sensor
4. Arduino Uno Microcontroller
5. LabVIEW™ Software
6. Tank

4. TESTING OF EXPERIMENTAL SETUP USING LABVIEW AND MICROCONTROLLER

As seen above, the controlling of water level in the tank was implemented using Arduino Uno Microcontroller and using LabVIEW™ software. The results obtained using both the interfacing methods are discussed.

A. Experimental Set-up in LABVIEW™

The components of the set-up are assembled together starting from the Ultrasonic sensor. The Ultrasonic sensor is connected to the microcontroller, from where the signal is sent to the LabVIEW™ software. The amplified voltage from the controller designed in LabVIEW™ using LINX is given to the two terminals of the relay. The normally closed terminal of the relay is connected to one terminal of the pump while other terminal of the pump is connected to 220V AC mains supply. The inlet pipe of the pump is connected to the water supply and outlet pipe is connected to the tank. Both the inlet and outlet was properly sealed to prevent leakage.

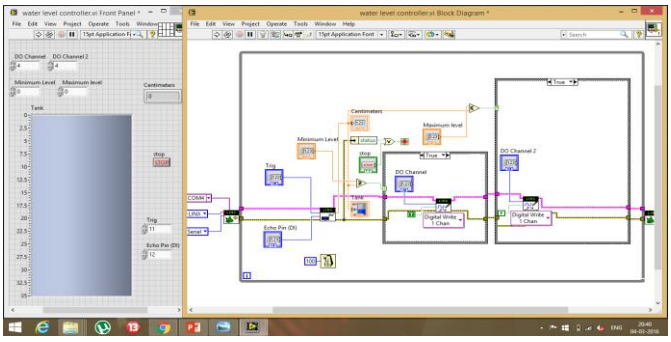

Fig 2. Simulation in LabVIEW™ using LINX interface

A. Experimental Set-up in Arduino Uno

For achieving the objective of automatic pump control the best method is to use a microcontroller. Once fed into the board, there is no need of tampering with the code. Also, as Arduino Uno is open source hardware, changes in the code can be made by anyone depending on the application so long as the person has basic knowledge of C++ programming language. The water level in the tank is what actuates the float. The Arduino receives the voltage signal from the float. On account of the code written, the terminal specified in the code gives a high (5V) or low (0V) signal to the relay. The relay acquires this signal and switches on or off the pump automatically, thus resulting in instantaneous pump cut-off.

Fig 3. Front view of Microcontroller setup

Fig 4. Side view of Microcontroller setup

5. CONCLUSION

The experimental set-up for controlling the liquid level is designed and developed successfully. The system was designed successfully using Arduino Uno microcontroller for two level. Automatic control system has been introduce to control water level (low level and high level) in a tank. Closed loop control system has been implemented and tested successfully using LINX interface for LabVIEW™

6. ACKNOWLEDGEMENT

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