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Distant Monitoring and Controlling of Gated Dams using PLC and SCADA

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Abstract- Dams are important to a country's economy as they are means of power generation, irrigation, enhancing of tourism, water conservation and many other purposes. The technological progressions in the present world has affected most of the processes of efficient and communal infrastructure which aims to work and make human life more suitable, comfortable and easier. However, there are still lots of areas such as water controlling where many powers that use manual systems for monitoring as well as controlling the gated dams. As the manual one is less accurate and time-consuming process, this proposed Automation System will permit the end user to observe as well as control the gated dams distantly using PLC device and SCADA software which minimizes the error and time while reducing the cost and increasing the quality of monitoring and controlling with added human safety measures.

Keywords: **Dam Automation, Spillways, PLC, SCADA, etc.**

1. INTRODUCTION

75% of Earth's resources constitutes by water and has been harnessed by human beings for various determinations; one of them is to generate electricity through dams. Hydroelectric power stations produce nearly 17% of electricity in India. Hence, it is an essential part of daily lives. The structure of dam may be of any size or to serve the purpose that they had been intended for. But it should require proper planning and allocation of assets. Any type of dam is able to give the results that are unsatisfactory or in extreme cases, even unfavorable to human welfare. In India, hydroelectric dams fulfil a major role of electricity generation requirements. India's generated power by hydroelectric sources is about 46GW in 2016-17 [6]. There are around 3200 notable large reservoirs and dams in India, few of famous dams are Bhakra Nangal, Tehri Dam, Hirakud Dam, Khadakwasla Dam, Radhanagari Dam, Ujjani Dam and Koyana Dam, etc [2].

Dams are the functional income possibilities that they serve as great places of conserving forests and wildlife while attracting tourists. Sometimes these dams may put these tourists or residents' lives under risk. The present flood gates do not serve this purpose of spreading tourism, while at the same time, guaranteeing safety of human lives in and around the spillway of these dams [1].

Dam operation to manage the floods should guarantee the dam safety, minimize the risk of flood downstream and operate and sustain the reservoir at full operative capacity once the flood is over. However, water management system is now a matter of growing concern. Rationally limited water supply, conservation and durability policies along with the infrastructure difficulty for achieving consumer and irrigation requirements with quality level help to make water management a challenging regulation problem.

The negligence to tourist safety concerns resulted into the Larji dam disaster in 2014. It is therefore crucial to implement an automated controlling and monitoring of gates which considers the presence of human beings. The aim of this paper is to provide a distant monitoring and control of gated dams using Delta PLC and SCADA software.

2. LITERATURE REVIEW

Design and development of an Autonomous floodgate using Arduino Uno and motor driver controller has been presented in [4] using level sensors situated at the drain side, which is used to detect the water level and deliver a signal to the Arduino. There is a use of micro switch incorporated here to detect the position of gate, it is either open or close. Arduino UNO is used here as the main processor, which examines the data provided from the water level sensor and micro switch. After completion of analysis process, a signal is sent to the L293D motor driver, which controls the motor to open and close the dam conferring to the output.

A paper on PLC based Dam Automation System has been presented in this system [2]. Here the targeted devices can be controlled by PLC. The main purpose of this project is to develop a PLC based system which detects the water level in dam and thereby automatically controlling the movement of gates. Only one dam has partial automated dam controlling system (Ukai dam on Tapi River at Surat). In all over India only one canal has fully automated gates. The programmable logic controller is used as an industrial computer playing a role of control device while micro switch provides incoming signals to the control unit where the real time implementation of gate is controlled by DC motor.

3. METHODOLOGY

The main aim of this project is to open or close the gates automatically and the main objective of this paper is to establish a system to control dam as well as monitor it distantly so that it can control the water flow autonomously to make an effective use of water to control the flood and serve other purposes. Figure 1 shows basic block diagram of the proposed system.

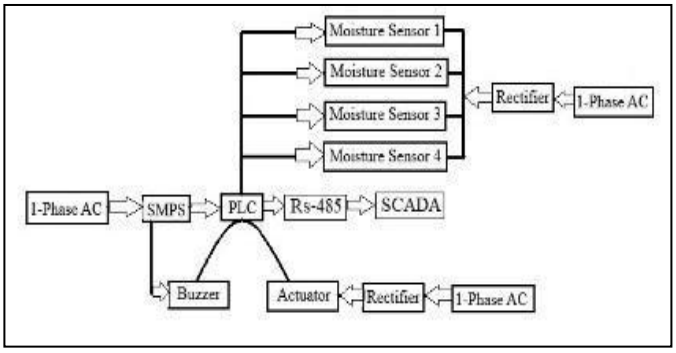

Fig- 1: Block Diagram of the proposed System

The overall process of the system where volumetric water level sensors are used to sense the level of water and deliver a signal to the PLC using relays. The DELTA PLC works as a main control system which controls the position (sequentially) and time counting by analyzing the signals sent by the sensors. Signal further sent to the automotive lock actuator. A separate supply is given to the volumetric water level sensors as well as actuator. There are four water level sensors situated at different levels. When water level reaches to the critical level or goes beyond it, the buzzer/alarm gets activated and buzzes for 5 seconds resulting into the opening the gates. Similarly, when the water level reaches to the drain side, the signal will be sent back to the PLC and the gate will be closed by actuator.

The SCADA screen is available to visualize the real time status of water level along with gate position and indication of alarm.

4. DESIGN AND OPERATION

4.1 Hardware interface

In this project, PLC is used as the main processor. Volumetric water level sensors are used to detect water level as Automotive Lock Actuator is used to open or close the gate, both of which are supplied by rectified DC supplies. The inputs are given to the PLC from volumetric water level sensors when water level does get sensed by the corresponding ones. The hardware interfacing is illustrated in figure 2. The processor PLC receives the continuous 24V DC supply through SMPS (Switched Mode Power Supply). PLC is then connected to the SCADA software in real time via Rs-485 Mod bus. The output actions are shown by Actuator-up, Actuator-down and buzzer. Y0 and Y1 outputs from the PLC activate PCB relays which then controls the gate position.

4.2 Circuit diagram

Figure 2 shows the complete circuit diagram of the project which consists of water level sensor, automotive lock actuator, Delta PLC, SMPS, SCADA software, Songle and PCB relays. The X0, X1, X2, and X3 input ports of PLC are connected to the outputs of volumetric water level sensors. The Y2 output port of PLC is connected to buzzer and Y0, Y1 ports are connected to the actuator-up and actuator-down respectively. PLC and SCADA are connected to each other through Rs-485 Modbus.

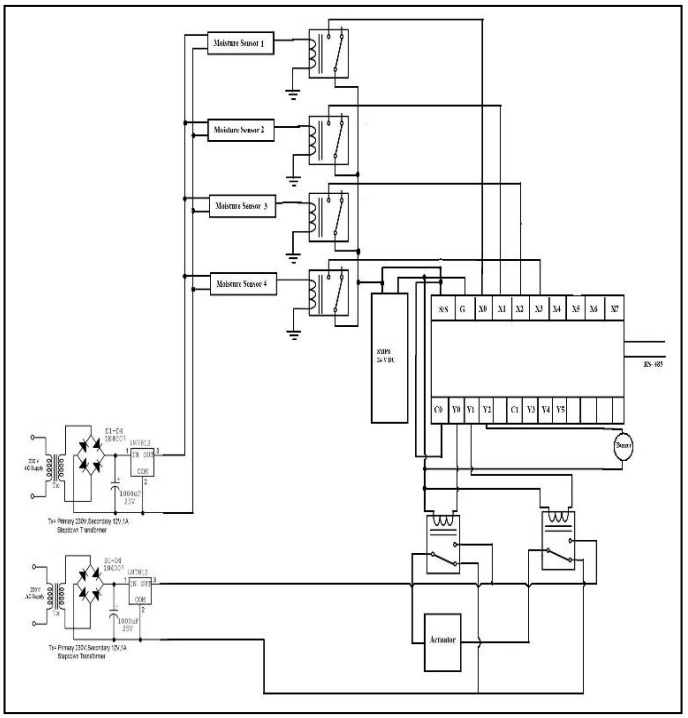

Fig- 2: Circuit Diagram of the proposed system

The sensors and actuator are both supplied by rectified 12V DC supplies. The 12V rectified DC supply consists of primary 230V, secondary 12V 1A stepdown transformer, diode bridge rectifier, capacitor and a LM7812 voltage regulator. SMPS supplies continuous 24V DC to PLC. The connections of output relays are inverted to get 'up' as well as 'down' movement.

4.3 Circuit operation

Normally water level is at X3 and gate position is closed. When water level starts increasing, SCADA shows the real time status of water level. When water level reaches X0, i.e., the critical level or goes beyond it, the alarm gets activated and buzzes for 5 seconds resulting into the opening of gates. As water level decreases, one can view it in SCADA. When water level reaches X3, gate automatically closes to keep water at normal level.

5. RESULT AND DISCUSSION

Figure 3(a) shows the overview of the system. Delta DVP14SS2 PLC is used as a processor for handling data from the sensor and for taking decisions for gate's movement. Volumetric water level sensors are employed for sensing level of water. For powering up the complete unit, two 12-volt power supplies are used. A SCADA software is used for showing the real time status of the water level and the position of dam gates. Figure 3(b) shows the circuitry of the system.

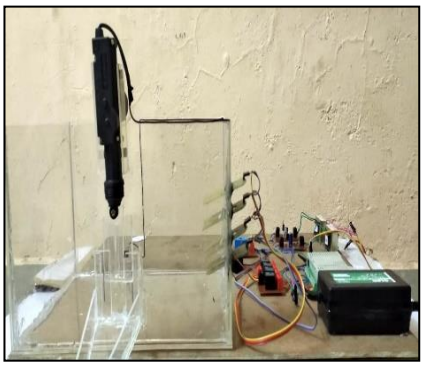

Fig- 3(a): Overview of the system

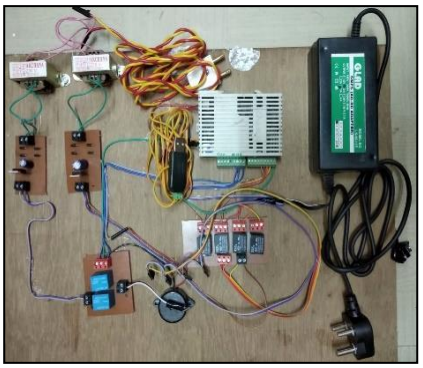

Fig- 3(b): Control circuitry

5.1 Gate movement

The movement of the dam gate is shown in figure 4. If the water level is above critical and the gate which is closed usually, the PLC sends a signal to open the dam gate and vice versa. Figure 4(a) shows the closing of the gate and 4(b) shows the opening of the gate. Figure 5 illustrates the water level sensors.

Fig- 4(a): Closed position of Gate

Fig- 4(b): Opened position of Gate

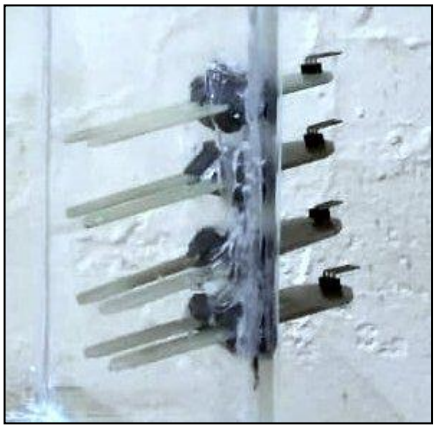

Fig- 5: Water Level Sensors

5.2 SCADA status

Figure 6 shows the display of the gates and water level. When the water level is from X1 to X3, the gate remains closed, the display shows the closed status and when the water goes beyond X0 level, the gate opens, the display shows the opening and closing status in figure 6(a) and figure 6(b).

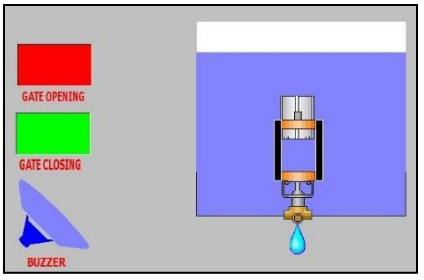

Fig- 6(b): Opening of Gate

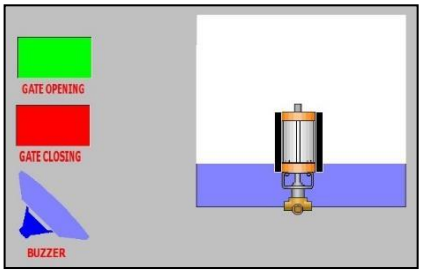

Fig- 6(b): Closing of Gate

6. CONCLUSION

PLC and SCADA are the better tools for controlling and monitoring actions. Delta PLCs offer a broad range of controllers and modules which all feature high performance, multiple functions and efficient program editing tools in addition to the user- friendly programming software and faster execution speed. For small scale it is costly but for large scale it is efficient. Our proposed method conserves water and ensures efficiency. The data is recorded in real time which will help the user to analyze the water level. This technology is much more user-friendly, easily operable, simple to implement, and robust. This system is capable of fulfilling the described goals of the project with the added focus on human safety, in order to prevent disasters.

As the advantages overshadow the drawbacks and it is more beneficial, reliable as well as economical, easy to operate though the skillful workers are required, it can be said as it is a need of the rapidly changing automated world.

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