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Automation of Gates of Water Reservoir Using Programmable Logic Controller (PLC)

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Abstract: This paper is intended as an overview of automation of gates of water reservoir. Water reservoir are crucial to country's economy as they are the resources of power generation, irrigation, water conservation and so on. This paper is focused on automation the gates of water reservoir and controlling variable parameters like level and flow of water with real time implementation using programmable logic controller. In this paper, a programmable logic controller is act as an industrial computer, playing role of a control device and level sensors provide incoming signals to the control unit. The prototype model is provided with five levels and depending on the level sensor outputs, ladder logic is actuated. This work uses PLC of Semeins-Simatic S7300 with 32 digital I/O and 8 analog I/O.
Keywords: Automation, Ladder logic, PLC, Level Sensor, Reservoir Gate Control

I. INTRODUCTION

Water constitutes 75% of Earth resources and has been harnessed by human beings for various purposes; one of them is to generate electricity through reservoir. It nearly contributes 17% of India's electricity and thus act as an integral part of our daily lives.[Shah T.,2008]. Reservoir may be built of any size to serve the purpose that they had been intended for. But without sufficient planning and allocation of resource, any dam could give result that are unsatisfactorily or in extreme cases, even harmful to human welfare. It not only provides electricity but also used for irrigation, domestic water supply and for flood control. It also serves as great places of conserving local flora and fauna and attract a great number of tourist.

II. METHODOLOGY

The input signals are given to the PLC. The input devices can be pushbutton, level switches, limit switches, sensor etc. The output of the PLC is given to the final control element. The output elements can be valves, motor, control relays, alarms, and siren. They control the opening of the gates and the feedback signal provide continuous monitoring of the exact water level in the reservoir. The feedback signals are compared with threshold values of the main program which is used to open / close gate of reservoir for flood control.

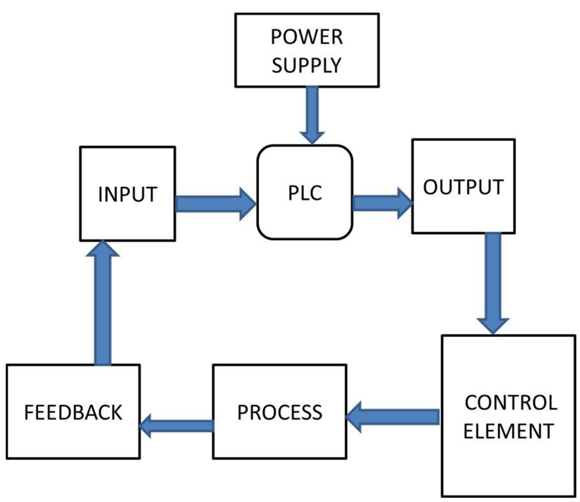

Figure 1. Block Diagram

Describing this system starting with the components that may be best suited for practical implementation, followed by a brief description of our proposed solution and lastly, the detailed process description.

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A. Programmable Logic Controllers

Programmable Logic Controller (PLC) is a controller used for the control operation of machinery and manufacturing process. It has a programmable memory which is used to store instructions and execute functions including counting, timing, sequencing, on/off control, arithmetic and data handling. For this, we use the PLC SIMATIC S7-300 of SIEMENS in Simulation Mode, as this particular PLC is flexible, fast, offers good memory capacity and various networking options through CAN, Ethernet, Ether Cat, etc.

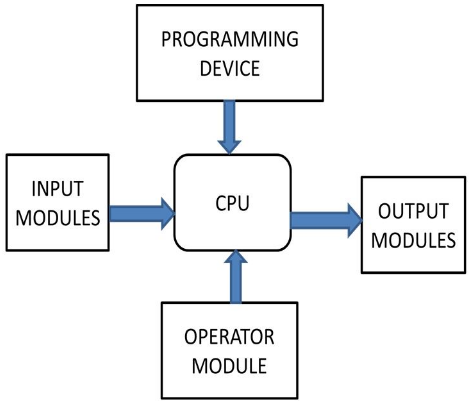

Figure 2. Block diagram of PLC

B. Ladder Logic Programming

Ladder programs are used in large, complex systems that control industrial automation, process control, manufacturing and assembly lines. Programming in ladder logic provides ease of use, easy functionalities, flexibility and helps in incorporating changes better. PLC programming through ladder programming is thus a suitable, less-cumbersome way of operating large systems, like gates of dams.

C. Actuation of Gates

Gates of reservoir are adjustable gates used to control water flow in flood barriers and reservoirs. Gates generally enclose the water in the reservoir, giving them a one-way, open/close passage to the spillways. The actuation of gates is implemented with PLCs, whereas the ladder program takes care of controlling the opening and closing of the gates as and when needed, or following interrupts that may occur in the program operation sequence. This is beneficial also because the response time of the system controlled by PLCs usually range within microseconds to milliseconds.

D. Level Sensors

Mechanical float level sensors are the most widely used type of sensors for automation purposes. The sensor consists of a lightweight float suspended at the liquid level that moves vertically with changing water level. Thus, when the water level rises above preset height, the level switch trips to give logic 0 and when the level is below the preset height, the circuit is complete and results in logic 1 which is the default state of the sensor.

E. Process Description

The reservoir consists of three level sensors at the entry point of the water from the reservoir to the floodgates- LS1, LS2 and LS3 as shown in the figure 3. Initially, we consider that the water in the reservoir is below the lower level (LSl); this implies that water in the reservoir is below the minimum level, therefore we require all the gates to be closed. Next, when water in the reservoir rises above LS1, and it is the operation time of the dam, we open gates so that water fills the canal. When water in the reservoir rises above LS2, then we open the gates so that the water flows down to the turbines for power generation. When the water is above LS3, a siren rings to alert them to open the gates of reservoir. At the same time, the floodgates are open to direct water from Gate channel, thereby minimizing the risks of flooding near the banks of the reservoir. It remains open until water lower down to the level of water in the reservoir. Lastly, in case water level goes below LS3, they are detected by the sensors and floodgates are close so that water level is maintained for its multipurpose uses in the reservoir.

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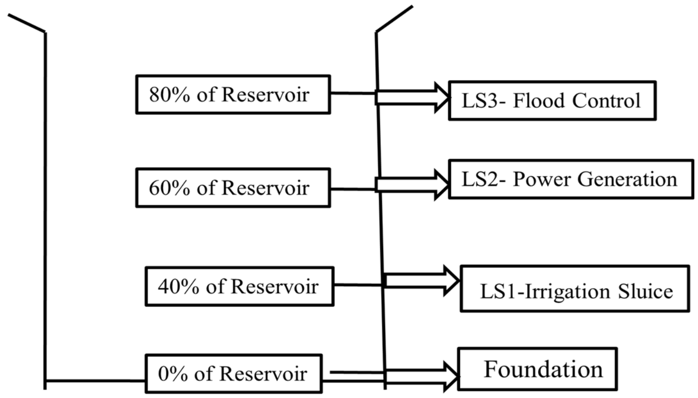

Figure 3. Layout of Water Reservoir

III. LADDER PROGRAM IMPLEMENTATION

Each gate is represented by three level sensors- LS1, LS2, LS3.

A. LS1 = 1 when water in reservoir reaches the dead level i.e. 40% of reservoir.
B. LS2 = 1 when water level reaches upto 60% of reservoir.
C. LS3 = 1 when water in reservoir reaches the higher level i.e. 80% of reservoir and needs to be released.
D. Rung-1: When LS1=1, then water level rises above 40% of reservoir, thereby opening Gate 1. Timer T1 counts down to the set time and energizes an intermediate output. When the gate is closed then, Timer goes off after 10 sec.
E. Rung-2: Once LS2 = 1, then water level rises above 60% of reservoir, then gates should be immediately be open and Timer T2 counts down to the set time and energizes an intermediate output and Gate is opened. When the gate is closed then, Timer goes off after 10 sec.
F. Rung-3: When LS3=1, then water level rises above 80% of reservoir, Gate should be immediately open, so that water will not get over-flooded and the Timer T3 counts down to the time for dam operation. Gate should also be closed when LS3=0. When the gate is closed then, Timer goes off after 10 sec.

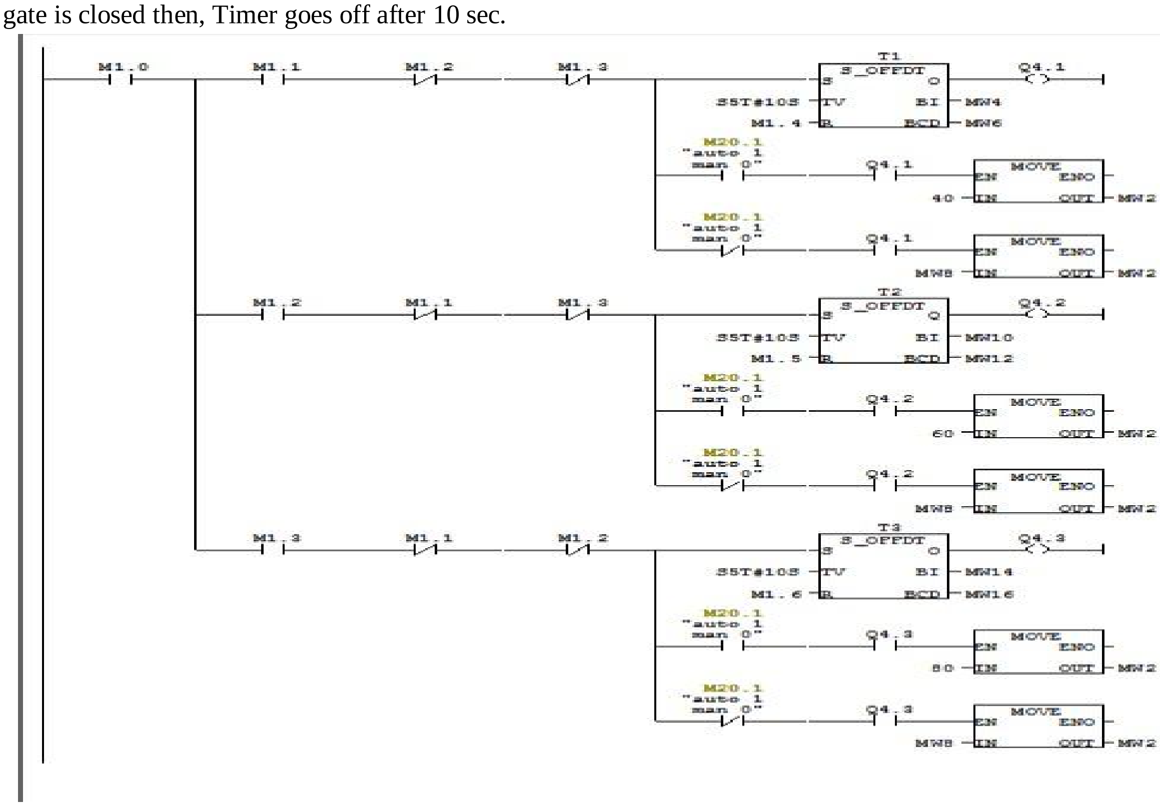

Figure 5. Ladder Diagram of automation of gates of water reservoir

IV. RESULTS

The system has been realized on SIEMENS- SIMATIC- S7300 in Simulation mode. The use of Ladder programming goes in line with its usage in controlling the operations of existing large-scale systems like dams. The algorithm for this program is a nobel initiative for upcoming plans of large or small hydro-electricity generation projects, that does not compromise on safety of nearby people on account of normal dam functions like power generation and irrigation.

V. CONCLUSION

The automation of gates has been implemented in Simulation Mode using PLC SIEMENS-S7300. As can be seen, the system is automated keeping in mind several factors such as level of water in reservoir, irrigation, time of the day and also of human beings near the gates. The added features of this system are water storage, servicing as a tourist destination, meeting irrigation demands while minimizing the potential dangers of such hydroelectric systems. This system is capable of fulfilling the described goals of the project with the added focus on human safety.

VI. FUTURE SCOPE

The use of PLC makes the system both power and cost- effective and also easy to be operated and maintained. Further extensions can be made on the system by:

A. Direct gate control using weather forecasts and satellite implications can be done. This would help make the system a lot more efficient and robust by upgrading its response to sudden situations like cloudbursts or floods.

B. In this system we are also use global position system. GPS are indicating for particular person will receiving message and alert through mobile.

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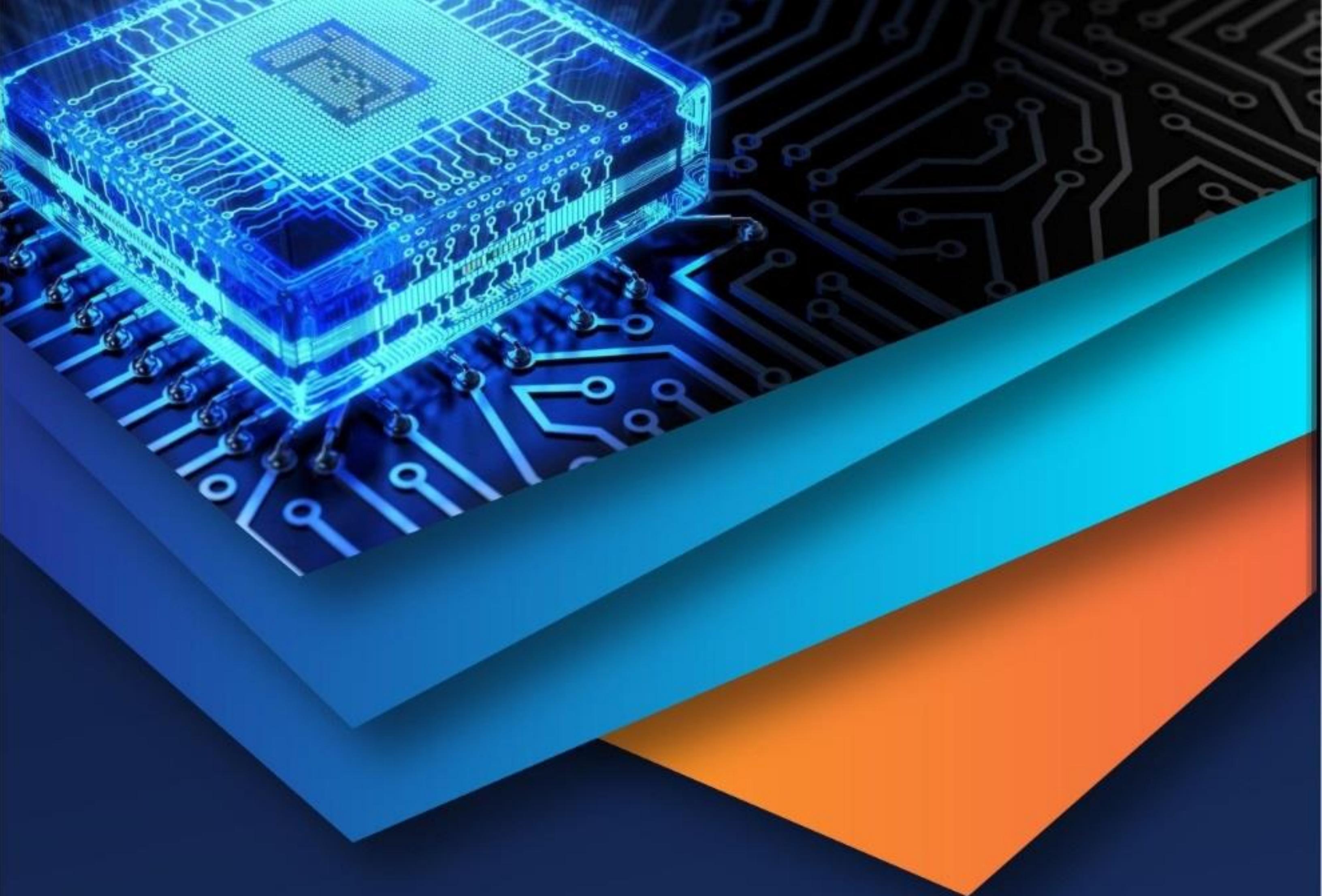

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