Gate Control System of Dam using Programmable Logic Controller

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***Abstract*—Water scarcity has become a serious problem in the world. There are many saving system for supply water from the dam. Therefore, the opening and closing of the gate of dam is very important to save water. The opening and closing of the gate is activated according to the level of water in the dam. The control systems of the gates of dams are done manually and using programmable logic controller (PLC). There are many errors in manual method than using PLC. For medium and small dams like irrigation dams does not require such huge PLC systems. In this paper, PLC is used to control the opening and closing of the gates of dams to save water resources from the dam for irrigation purposes and efficient operation of dam gate according to the level of water and also helps in indicating about flood to people living in the surrounding. This system consists of a set of float sensors, PLC FX2N20MR, relays and DC motor. A set of float sensor is used as input signal for PLC and used to detect the level of water. PLC is used to control gate of dam according to data from float sensors. Relays are used to drive dc motor for forward and reverse direction to close and open the gate. The working of this automatic system will completely depend on the ladder diagram programming method for PLC.**

***Keywords*— DC motor, Float Sensors, Ladder Diagram, Programmable Logic Controller, Relays**

I. INTRODUCTION

Controlling and automation of various processes, machines and devices is a fast growing business and application areas include fields as diverse as the industry, maintenance business, customer service, security, biology, medicine and social sciences. This paper presents the demonstration of a gate control system of dam, and to do so the controlling of gate of Dam is considered and for this purpose a miniature dam was also built as a testing and simulation model. To enhance the features the test model is also fully automated and includes a PC interface for user inputs for important parameters, such as threshold or cut-off water level for gate openings, flow rate and Manual/Automatic mode selection.The gate control system of the dam using PLC is used to control the flow of water so that it can be effectively used in the irrigation system. It will control the opening and closing gate according to the detected level of water in a dam. The functions of PLC FX2N20MR, float sensors, relays, DC motor and buzzer are studied to design and construct the gate control system of the dam using PLC. And ladder programming method is also studied to write the program used in PLC. In this system, the two float sensors are the main components of input in this system. The PLC is also the main components of this system to control. The relays are the connection between PLC and DC motor whether the motor drives forward or reverse. When the water level touches the sensors, the buzzer is rang up and the gate will open. The gate is controlled by the PLC.

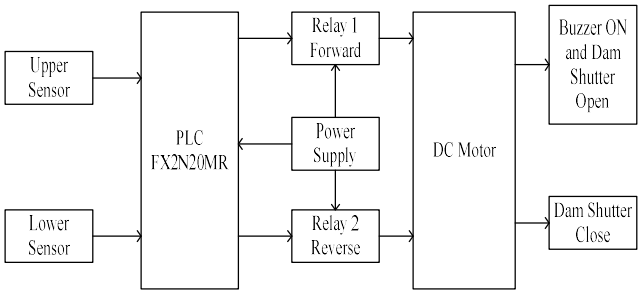


Fig. 1 Block Diagram of Gate Control System of Dam using Programmable Logic Controller

II. HARDWARE IMPLEMENTATION

The inputs of programmable logic control device are connected with water float sensors. PLC is required in 24 volt DC. The motor are connected toward relay driver because motor rotation in two direction. PLC is programmed by ladder diagram programming method, which strongly resembles a schematic diagram of relay logic. The actuation of gates is implemented with PLCs, whereas the ladder diagram 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.

The adjustable gates used in this circuit are relays. They are normally closed in initial stage. The Y0 and Y1 of the controller are connected to the relays of normally closed stages. The common pins of both relays are connected with motor and buzzer which are outputs of the system.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. The two level sensors are connected to the X0 and X1 of the control. They are the input of the whole system.

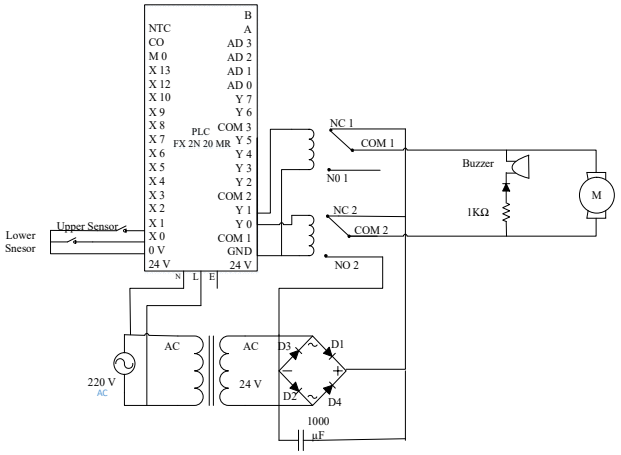


Fig. 2 Overall Circuit Diagram of Gate Control System of Dam using Programmable Logic Controller

The input signals are given to the PLC. The input devices are used as level switch sensor. The output of the PLC is given to the final control element. The output elements can be motor, control relays and alarms. They control the opening of the gates and the feedback signal provides 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.

III. System Flow Chart

Fig.3 shows the system flow chart of the gate control system of dam using PLC.

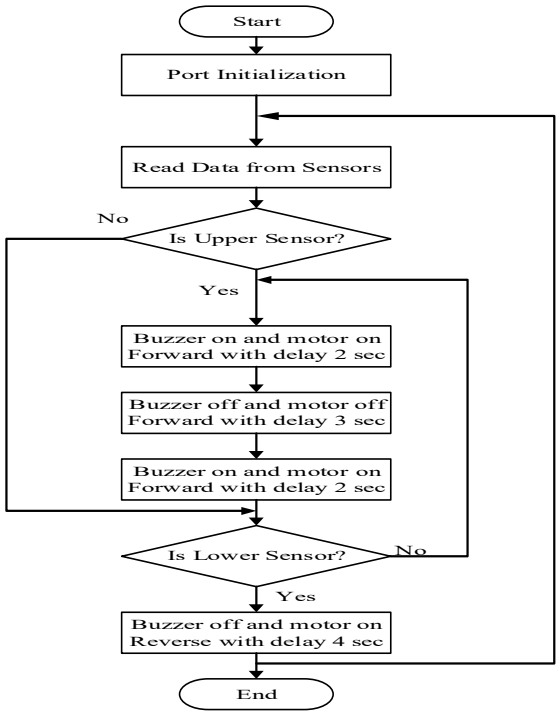


Fig. 3 System Flow Chart of Gate Control System of Dam using Programmable Logic Controller

Initially, all ports are ready. Sensors are ready stage. The system has two sensors. If the sensor1 is on stage, the buzzer is ON stage and opens the gate for a period of 2seconds. After the gate open for a period of 2seconds, the gate will stop for a period of 3seconds. Then, the gate will open again for the same time. If the sensor 2 is ON stage, the gate is closed for a period of 4seconds. This system is finished.

IV. Operation Of Ladder Diagram

The gate control system starts when the program is downloaded into the PLC. When the water level reaches the lower level, X000 or lower sensor is on until the water level reaches below the low level. When the water level touches the higher level sensor, X0001 or higher sensor is on and Y000 and Y002 are also on and motor run up for forward direction and buzzer rung up at the same time and then gate open for the first time. At the same time, timer T0 is on for a period of 2seconds. If the timer T0 is full time, the motor will stop. After timer T0 is on, waiting timer T1 is also on but motor is in early stage. After timer T1 is on for a period of 3seconds, Y000 and Y002 are on and motor and buzzer will do second time and then gate will open again for the second time. At the same time, timer T2 is also on. If timer T2 is full time for a period of 2seconds, motor will stop until the water level reaches the low level.

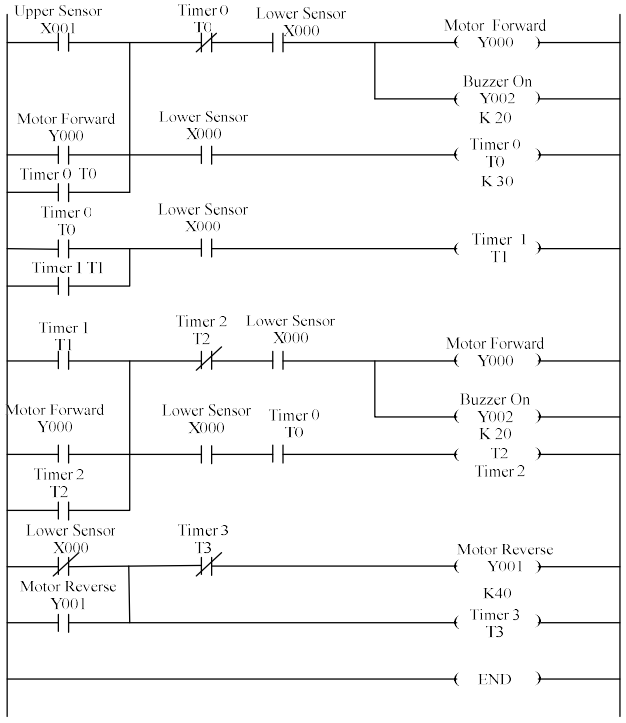


Fig. 4 Ladder Diagram of Gate Control System of Dam using Programmable Logic Controller

When the water level reaches the lower level sensor, X000 or lower sensor is on and Y001 or is also on and Y002 is off. At the same time, T3 is on for a period of 4seconds. After timer T3 is full time, the motor will stop and then gate will be closed. This system is finished.

V. TEST AND RESULT

A. Simulation Tests and Results

PLC ladder diagram is needed to simulate for checking. Fig. 5 shows the program running for starting of simulation.

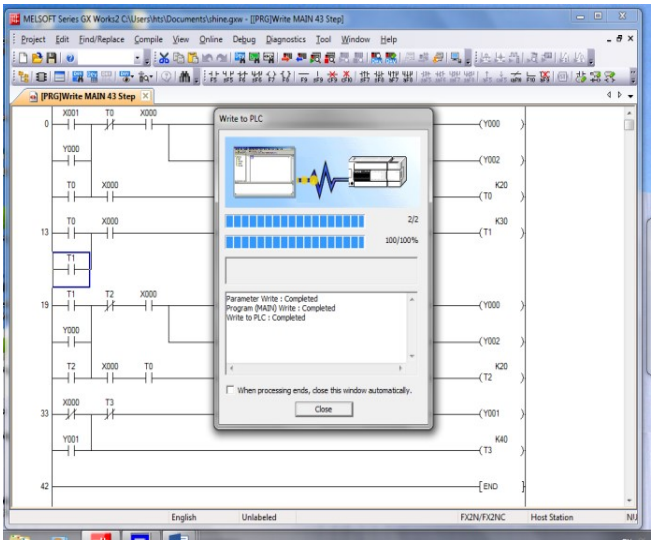


Fig. 5 Start Simulation of Ladder Diagram

After simulation starts, the simulation result of initial stage for opening and closing of gate is shown in Fig. 6.

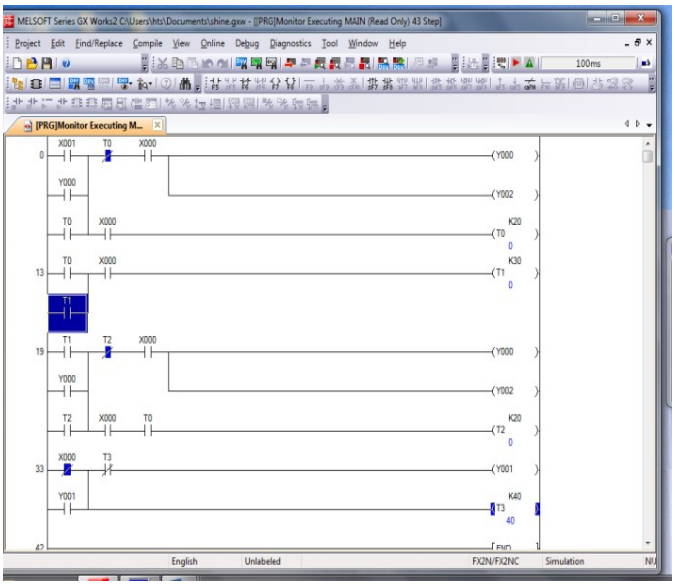


Fig. 6 Running Program for Initial Stage

When the water level reaches to the higher level, X001 is on and Y000 is also on and motor will run up and then the gate will open as first time. At the same time, timer T0 is on for a period of 2s.If the timer T0 is full time 2s, the motor will stop. The simulation result of opening the gate and counting time is shown in Fig. 7.

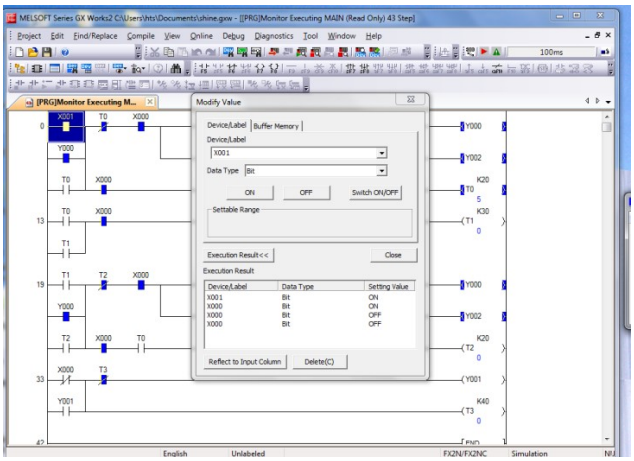


Fig. 7 Running Program for Opening the Gate and Counting Timer

After T0 is on, waiting time T1 is also on for a period of 3s and motor is in early stage. The simulation result of counting timer for waiting time T1 is shown in Fig. 8.

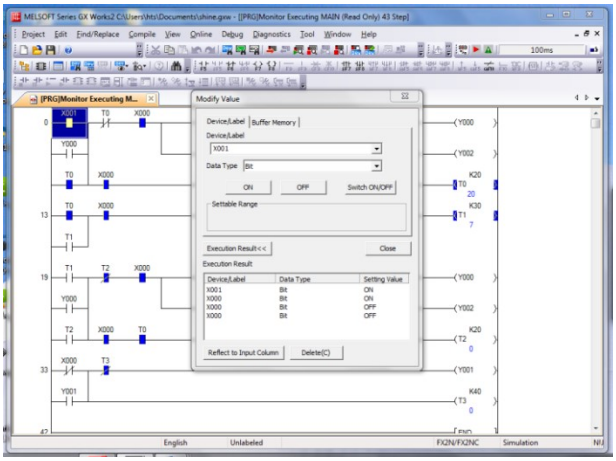


Fig. 8 Running Program for Waiting Time

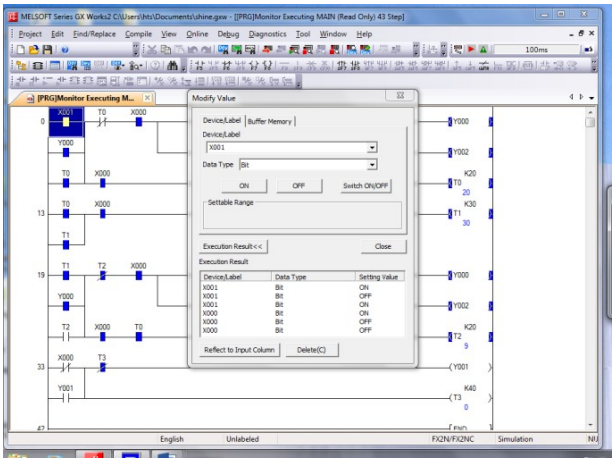


Fig. 9 Running Program for Second Stage of Opening Gate and Counting Timer

After T1 is 3s, Y000 is on and the gate will open again and T2 is also on for a period of 2s. If T2 is full time 2s, the motor

will stop. The simulation result of for second stage of opening gate is shown in Fig. 9.

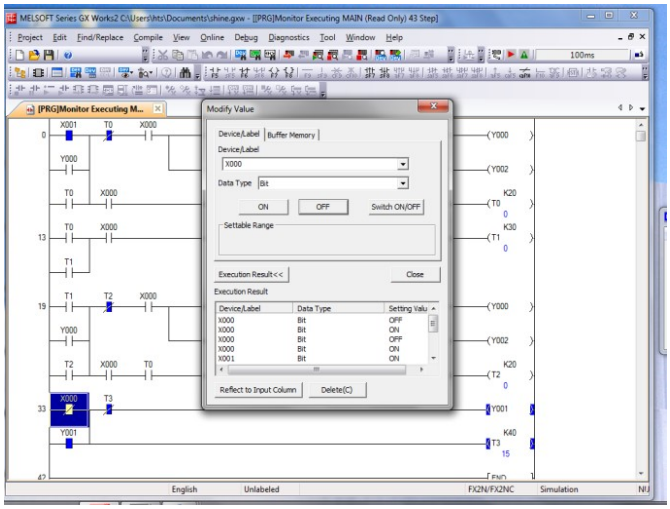


Fig. 10 Running Program for Closing the Gate

When the water level reaches the lower level sensor, X000 is on and Y001 is also on. At the same time, timer T3 is also on for a period of 4s. After the timer T3 is full time, the gate will automatically close. The simulation result of closing the gate is shown in Fig. 10.

Fig. 11 shows the simulation result of the overall finished result for opening and closing of the gate.

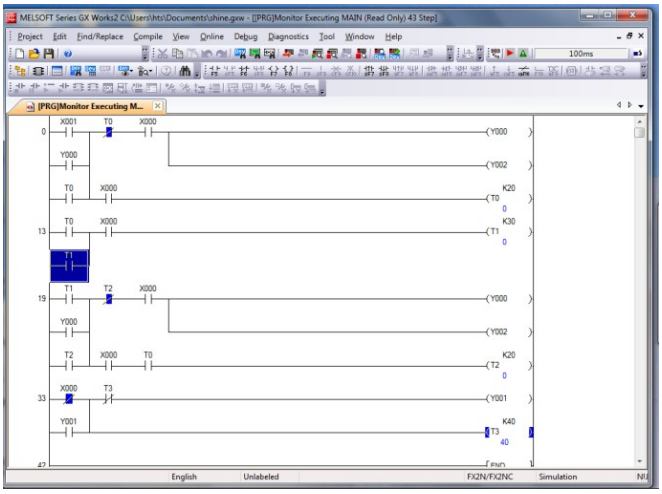
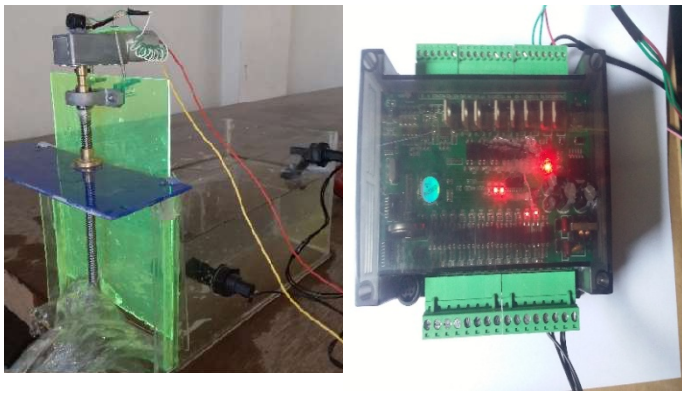


Fig. 11 Running Program for Final State of Opening and Closing of the Gate

B.Hardware Tests and Results

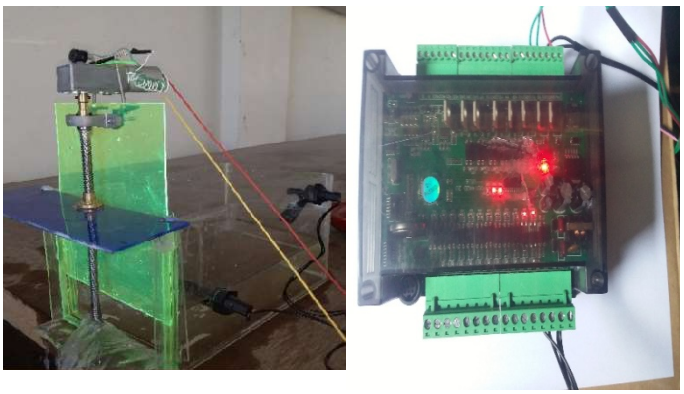
Stopping gates are adjustable gates used to control water flow in flood barriers, reservoir, river, stream, or levee systems. When the water level is reached the higher level, the gate of dam is opened as shown in Fig. 12.



(a) (b)

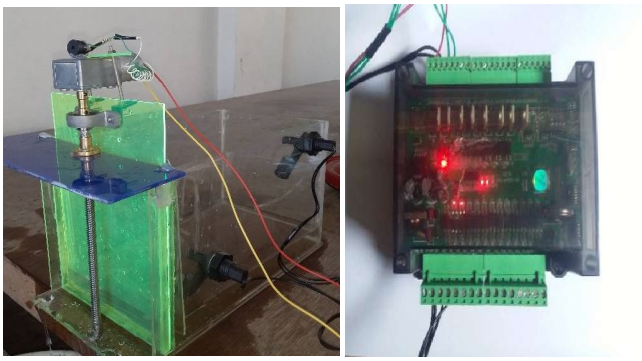
Fig. 12 Opening the Gate for the First Time: (a) for Dam and (b) for PLC

After the gate open for a period of 2s, the motor will stop for a period of 3s and then the gate will open again as shown in Fig. 13. When the water level is reached the lower level, the gate of dam is closed.



(a) (b)

Fig. 13 Opening the Gate again after First Time: (a) for Dam and (b) for PLC



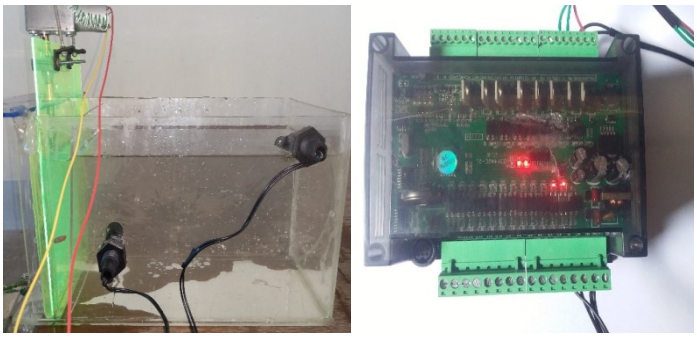
(a) (b)

Fig. 14 Closing the Gate: (a) for Dam and (b) for PLC

And then, when the water level is reached the lower level, the gate of dam is automatically closed for a period of 4s as shown in Fig. 14.

Water level sensor float switch is a device used to sense the level of the liquid within a tank.They are used as input signal

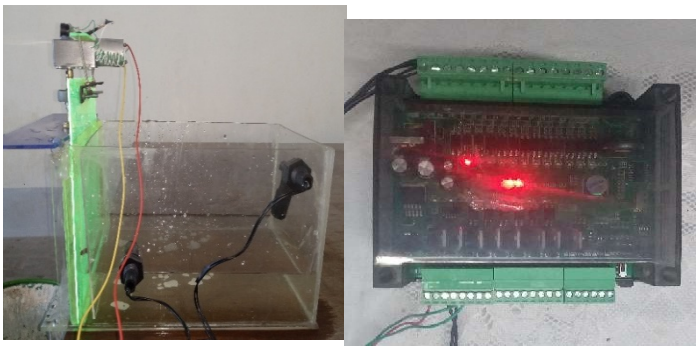
for PLCand to detect the level of water in the tank. Fig. 15 shows PLC displaying when the water level touches the upper sensor.



(a) (b)

Fig. 15 Water Level for Upper Float Sensor: (a) for Dam and (b) for PLC

Fig. 16 shows the result of PLC displaying when the water level touches the lower float sensor.



(a) (b)

Fig. 16 Water Level for Lower Float Sensor: (a) for Dam and (b) for PLC

VI. CONCLUSION

In this paper, it represents that motors are controlled automatically by using PLC and sensors. This model of gate control system of Dam is the completely automated by using PLC and can control the level of the dam gates using backup of the water. The level of water in the dam is controlled effectively there by opening and closing the gates of the dam whenever the level increases. Therefore the use of Programmable logic control has opened doors for a level of automation according to the signal from the sensors. Other applications of this system are automatic water flow in dams under emergency condition, household applications, industrial applications, water supply for villages in developing world, pond water management and water transfer.

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