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Automation of Model Canal

Tejas Kamble, Harshawardhan Khamkar,Mrs. A.A.Shinde
Student, kambletejas2509@gmail.com, 7208227604

Abstract— The main objective of the project is to study and develop a canal automation model using local material and interface with PLC SCADA . The model consist of 4 gate controllers (Robogates) installed in the canal model at downstream and rest of the 3 gates are manually controlled and consist of 9 Ultrasonic water level sensors for monitoring water level in canal. One is at head tank for monitoring water level in it, one at V-notch and three pairs are at gate number 4,5,6 for monitoring upstream and downstream water level and one is after gate number 7 for water level monitoring. Each Robogate controller is an embedded system designed. The Robogates are adjusted as per the condition to supply a certain amount of water in particular village area. The results showed that generally, the Robogates are very capable of controlling the water level in the model. The model consist of 4 turnouts across gate 4,5,6,7 having control valve as an outlet for releasing water in respected area. All activities of monitoring water level in head tank, in canal across the gates and controlling of gate position and valve position at turnout takes place through PLC and SCADA interface. The main purpose of this project is to improve the adaptive capacity of the agriculture and water sectors and to select and apply suitable climate and hydrological scenarios in future..

Keywords— SCADA, Micrologix1400, Modbus, Slip gate meter, Rubicon's Precision Level Sensor, Sharp crested Weir, V Notch, Long Throated Flume, VADCP.

INTRODUCTION

Automation of model canal project is sponsored by Central Water & Power Research Centre, Pune (CWPRS). Project consist canal model having dimensions 133.1m*6.44m. Initially flow accumulate at the inlet tank from pumped water. At the upstream end of model canal, an inflow measured through a sharp crested weir in to the canal is allowed. This discharge flow regulation is done through two sluice gates installed at other location of the same tank.

The pumped water is delivered into inlet tank through 0.3m diameter pipe. By adjust gate opening of the system manually operated two sluice gates at inlet tank, it is possible to regulate inflow into the model canal. The value of flowing discharge into the model canal can be known very accurately by measuring the head water above sharp crested weir. A water level sensor is installed here to measure the water level the crest of sharp crested weir. The water that is not in use is also returned to the underground reservoir through sink. It consist of head tank with gates to control the flow of water, 10 Rubicon acoustic water level sensors for precise water level, V-notch & sharp crested weir for measurement of water flow, one siphon to connect two canal parts, one long throated flume to control water flow, automatic gates and electrically actuated control valves and one feedback tank.

Canal automation as a key tool, implies that, once set control structure are able to maintain desired flow rate or water flow in the canal without manual intervention. A long crested weir is a simple hydraulic device requires no electricity or computer, where large variation in flow rate results in to smaller variation in water level. The project consists of water flowing from the head tank and passes through the gates where the level of the water is measured by the acoustic water level sensors for the correct level measurement. As per the required amount of water and accurate water level in canal indicates the system to open the specific gates at required fields. The command is given by the computer system through SCADA for the precise water flow required. The valve opens to flow the water to the fields. The V notch and sharp crested weir are to check or balance the water flow through the system.

HARDWARE DESIGN

SCADA

SCADA system with project specific features includes Water Resource Information Management System(WRIS) software that helps derive the water requirement in discharge term, across the distributaries, branches and reaches of the canal network from data obtained from Water User Association (WUAs) on the land holdings. As per the schedule water releases sets are monitored by accurate flow measurement and the data communicated in real time to a central monitoring station. The real time data compared with the schedule plan to assess the variance.

MicroLogix1400 (Small Programmable Logic Controller)

The new Allen-Bradley MicroLogix1400 from Rockwell Automation complements the existing MicroLogix family of small programmable logic controllers. MicroLogix1400 combines the features you demand from MicroLogix1100, such as EtherNet/IP,

online editing, and a built-in LCD, plus provides you with enhanced features, such as: higher I/O count, faster High Speed Counter/PTO and enhanced network capabilities Take advantage of the built-in LCD with back lighting to set the Ethernet network configuration, display floating point values on a user configurable display, display OEM logos at startup and read or write any binary, integer and long file elements in the data table. Three embedded communication ports provide with superior communications capabilities. MicroLogix1400 offers an isolated RS232C/RS485 combination port; a non isolated RS232C port; and an RJ-45 port for 10/100 Mbps Ether- Net/IP peer-to-peer messaging.

RS-485(Modbus)

The RS-485 standard, known as RS485, describes a communication interface that uses balanced data transmission over one or two pairs of wires to establish communication between 32 load units. Usually, each network device (transmitter and receiver) corresponds to one unit load, thus resulting in a 32 devices network. New devices can have fractional unit loads, increasing the allowed number of networked devices. RS485 networks usually communicate using a twisted pair of wires, where data flows in both directions. Each device turns on its line driver only when transmitting data, and keeps it off (in high impedance state) for the remaining time to allow other devices to transmit. Only one device can transmit at a time, which is called a half duplex operation.

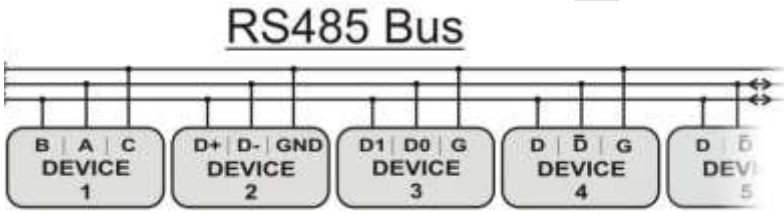

Fig 1. RS485 Bus

Electrically Actuated Control Valve

The valve is provided with a screwed-in seat ring and the standard version with a parabolic plug (equal-percentage or linear characteristic).For special applications valves with perforated plug (equal-percentage or linear characteristic) are available. For on-off control the valve is supplied with a disk-type plug (quick-closing characteristic).The electric linear actuator consists of a motor, transmission, spindle, pillars, and hand wheel. The actuator is triggered by a three-position stepping controller or direct via an electronic control system. Switching-off in the respective end positions is effected by two load-controlled limit switches and one position-controlled limit switch. The stroke action of the valve plug adjusts the area around the seat to regulate the flow.

Fig.2 Electrically Actuated Control Valve

Sharp-Crested Weirs

A weir is basically an obstruction in an open channel flow path. Weirs are commonly used for measurement of open channel flow rate. A weir functions by causing water to rise above the obstruction in order to flow over it. The height of water above the obstruction correlates with the flow rate, so that measurement of the height of the flowing water above the top of the weir can be used to determine the flow rate through the use of an equation, graph or table. The top of the weir, which is used as the reference level for the height of water flowing over it, is called the crest of the weir.

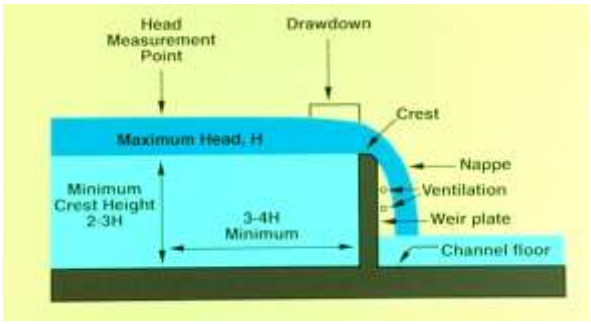

Fig.3 Sharp-Crested Weirs

Rubicon Precision Level Sensor

Rubicon Precision Level Sensor delivers industry leading reliability in harsh measurement environments. The Precision Level Sensor is specifically designed for the difficult environments encountered in level monitoring applications. The Precision Level Sensor measures within its own controlled measurement environment. Measurements are unaffected by surrounding objects, debris, foam, silt and other contaminants. The Precision Level Sensor features an integrated Reference-Mark, against which the sensor self-calibrates on every measurement. This Reference-Mark ensures that the sensor provides consistently accurate measurements independent of environmental disturbances. Integrated Ranging- Chamber permits laboratory accuracy in harsh field environments Self-Calibrates on every reading against precision Reference-Mark Modbus Data Interface.

V-notch

The V-notch sharp-crested weir is especially good for measuring low flow rates. The flow area decreases as H increases, so a reasonable head is developed even at a very small flow rate. A V-notch weir (sometimes called a triangular weir) is shown in figure(4).

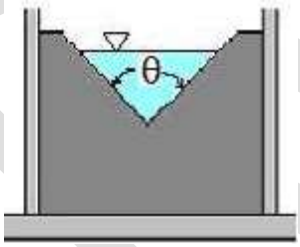

Fig.4 V-notch

Long-Throated Flumes

The term long-throated flume describes a broad class of critical-flow flumes and broad crested weir devices used to measure flow in open channels. Long-throated flumes have one-dimensional flow in the control section . Long-throated means long enough to eliminate lateral and vertical contraction of the flow at the control section streamlines are essentially parallel can be calibrated using well-established hydraulic theory. No laboratory testing needed.

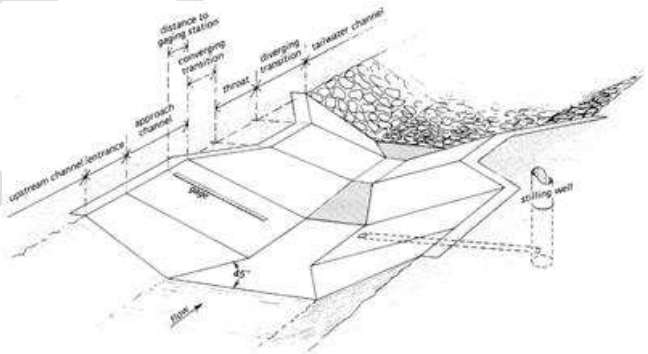

Fig.5 Long-Throated Flumes

Slipgate meter

The SlipMeter can be remotely pre-set to turn on and off automatically to deliver a constant and accurately measured flow rate and volume. This means you can provide a great service day or night, even when supply canal levels are fluctuating. The SlipMeters ability to measure accurately at high and very low flow rates means it is suitable for all crop types. And the extremely low head loss means that command is not compromised even when very little head is available.

Fig.6 Slip gate meter

VADCP

The Vertical Acoustic Doppler Current Profiler (V-ADCP) is designed for high-accuracy measurement of water flow and level and velocity profile in open channels. The new generation V-ADCP uses Broadband pulsed-Doppler technology, which provides high precision and resolution in water velocity measurements. Acoustic Doppler Current Profilers (ADCPs) measure time series of speed and direction of water flow at many depths. Because they use a broad bandwidth signaling method, ADCPs provide more information in less time. As a result, the Broadband data are much clearer than the original ADCP method.

Fig.7 VADCP

SOFTWARE DESIGN

The basic two software's used in this system are

SACAD

SCADA is supervisory control and data acquisition system which is used for controlling various real time operation on field. Operations like controlling gate positions, control valve position. SCADA system collect all the real time data from field as well as from user computer and give specific command to control water level in canal and distribution system in various field. SCADA is one of the best and highly engineered system which is used for large geographical area control. SCADA (supervisory control and data acquisition) is a system operating with coded signals over communication channels so as to provide control of remote equipment (using typically one communication channel per remote station).

Micrologix1400

The Allen-Bradley MicroLogix1400 from Rockwell Automation complements the existing MicroLogix family of small programmable logic controllers. Expand your application capabilities with up to 7 expansion I/O modules for a maximum of 256 discrete I/O. 6 embedded 100 kHz high speed counters (on controllers with dc inputs). 2 Serial ports with DF1/ DH485/ Modbus RTU/DNP3/ASCII protocol support. Ethernet port provides you with EtherNet/IP, DNP3 over IP and Modbus TCP/IP protocol support as well as web server and email capabilities. Built-in LCD with backlight allows you to view controller and I/O status, and provides a simple interface for messages, bit / integer monitoring and manipulation

FLOW CHART

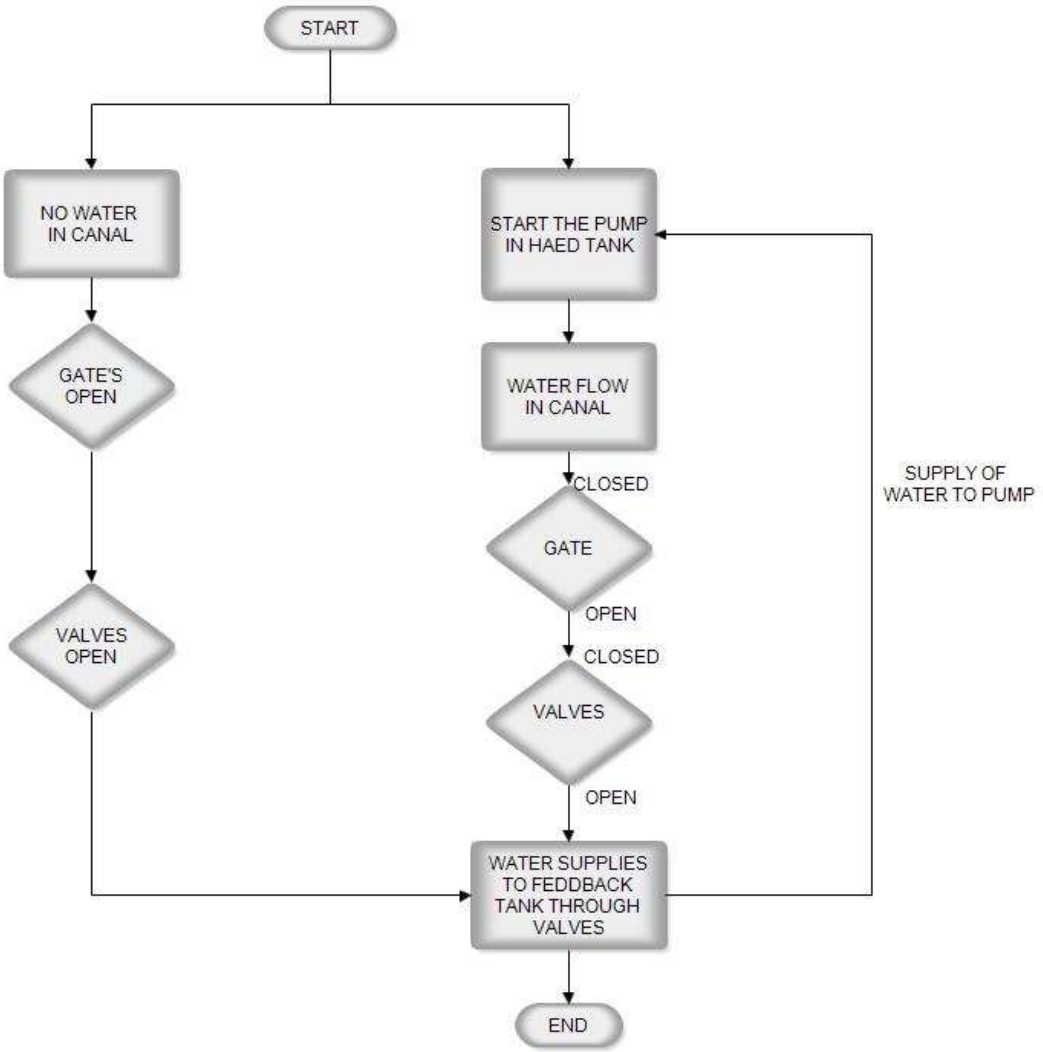

Fig. 9 Flow chart

OBSERVATION

The SCADA system with project specific features include water resources information management system that helps derive the water requirement in discharge terms across the distributaries branches. As per the schedule water release sets are monitored by accurate flow measurement and data communication in real time to central monitoring station.

ACKNOWLEDGMENT

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CONCLUSION

The main purpose of the automatic control in open channel hydraulic system is to optimize the water supply distribution, in order to match the expected water demands. Conceptually, as automation involves flow measurement at several location, it shall trigger the adoption of volumetric approach in water application.

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