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A Study on Rainfall and Reservoir Level Measurement for Dam Automation

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ABSTRACT: The government requires certain data on a regular basis in a dam. These data comprise of rainfall measurement in a certain area, the level of water present in a dam and the position of the gates of a dam. A simple yet effective system has been developed to measure these parameters. These parameters have to be sent to the government's website. This paper deals with the hardware aspect of the measurement of two of the three above mentioned parameters on the remote dam locations and sending the values of these parameters to the government's website. A PLC is used to get the data from the sensors and display the same on the remote location. Using a GSM modem, these values are then dumped on the government's server. The hardware aspects of this project are taken into consideration in this paper.

KEYWORDS: Radar level, Rain Gauge, PLC, GSM Modem.

I.INTRODUCTION

The government has a requirement when it comes to dams. Every dam must have a set up in which one can measure certain parameters required by the government and see them online on the government's website. The three such parameters are-a) Amount of rainfall in a certain area, b) Level of the water present in a dam, c) The amount of dam gates opened/closed. A system has been designed to measure two of these parameters, display them on the dam location and send the data to the government's website. For the purpose of measurement of the required parameters, a PLC is used. A rain gauge sensor measures the amount of rainfall in a specific area. A radar level sensor measures the level of water that is present in a dam. The system is easy to interface and highly efficient. The sensors send their respective data to the PLC which displays this data on its HMI and sends the same to the government's server via a GSM modem.

II.APPARATUS

1) Selec Flexys Panel TX4 with high speed counter: This PLC is user friendly. It has expandable input output ports. It accepts the following input signals from sensors-a) Voltage: 0-10V, 0-60mV, b) Current: 0-20mA, c) J,K type RTD etc.This PLC was selected mainly for its capacity to interface I/O ports. Its supply voltage range is 18-26V.[1]

2) Radar level sensor- RLS: This sensor by OTT Hydromet measures the level of water in a reservoir or dam. It is used for non-contact measurement of the levels of surface water. It works on impulse radar technology. It has an output of 4-20mA which is given to the PLC as Analog Input (AI). It requires a supply voltage of 9-28V.[2]

3) Tipping bucket rain gauge TB4: This rain bucket by Hydrological Services Pvt. Ltd consists of two buckets that tip over when 0.5mm-1.0mm of precipitation falls in it. The amount of precipitation after which the buckets should tip is adjustable. A reed switch detects the tipping of the buckets and creates a momentary contact closure signal which is given to the PLC as a Digital Input (DI).[3]

4) GSM Modem Robustel GoRugged M1000 XP: This is a compact design serial to cellular gateway with plastic housing, offering state-of-the-art GSM/GPRS/UMTS connectivity for machine to machine (M2M) applications. This

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modem supports Modbus RTU to Modbus TCP and has serial interface standard RS232 or RS485. The PLC has communication protocol RS485 and hence this modem is best suitable for the application.[4]

III.CONNECTION DIAGRAM

As shown in Fig. 1, the TB4 tipping bucket output given to the PLC. The radar level sensor has two wires for data transmission viz. pin4 (AI+) and pin5 (AI-). Pin1 (Supply 24V) and Pin7 (Ground) are power supply to the sensor. [2] The connections of the sensors are done with the PLC accordingly.The PLC is also connected to the 24V supply for its operation. The PLC is connected to the GSM modem using RS485 communication, which sends the signal to the government's website.

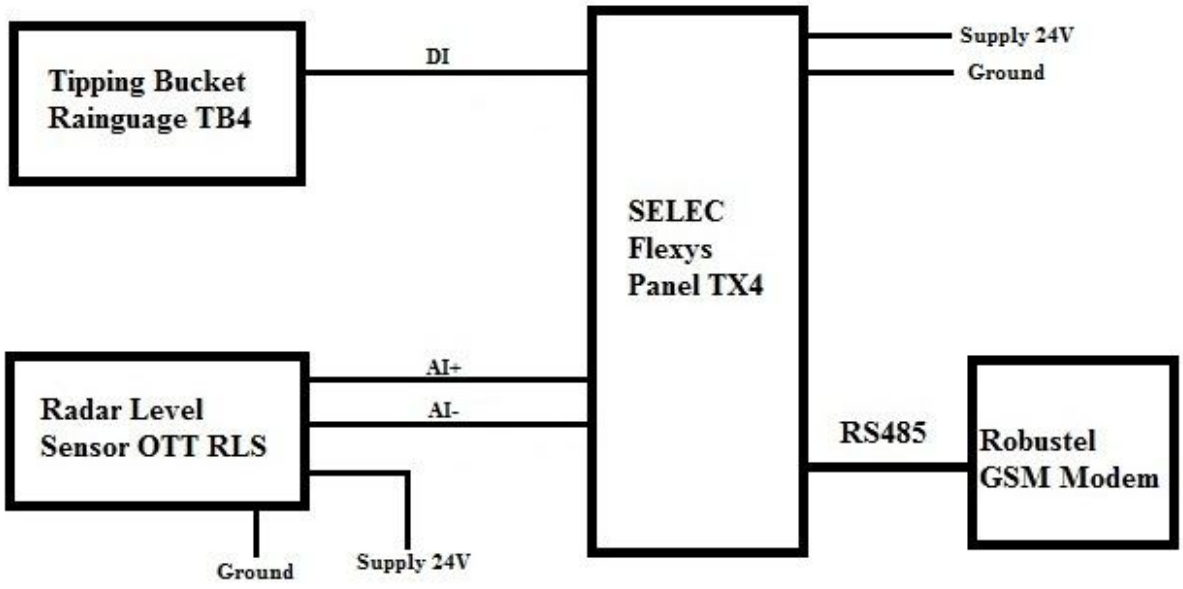

Fig. 1 Connection Diagram of Dam Automation System

IV.WORKING AND METHODOLOGY

Since the power supply required by the apparatus demands a 24V DC supply, two 12V batteries are connected in parallelor single 24V battery can be used as the power supply. The tipping bucket does not require a power supply. It only sends high current pulses to the PLC when its circuit is momentarily closed due to the tipping of the buckets.[1][2][3]

When all the connections are made, the radar level sensor takes 20 seconds to initialize. Its transmitting antenna transmits short radar pulses in the 24GHz ISM band. The separate receiver antenna receives these pulses reflected from the surface of the water and uses them to determine the distance between the sensor and the surface of the water. The actual water level of the reservoir is then calculated automatically by the sensor. On its initial start-up, reference values and relevant measurement modes can also be inputted.[2]

The TB4 rain bucket operates on the tipping bucket principle. A receiver of 200mm diameter collects the rainfall which is strained by a metal gauge before being passed to the tipping bucket measuring system. There are two buckets in the sensor which tilt whenever a certain amount of rainwater falls into it. That certain amount is carefully calibrated to be 6.5ml as per the government's recommendations. The tipping buckets have syphons installed over it which controls the amount of water that falls on the buckets at the same time. This precaution is necessary because the tipping buckets are highly sensitive. After every tip, a momentary closed circuit is created and a high current pulse is sent to the PLC. The number of such pulses multiplied by the amount of water that is required by a bucket to tip determines the amount of rainfall occurred in that region. [3]

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The data from the radar sensor and the tipping bucket received by the PLC is viewed on the PLC which is located on the dam site. As the PLC is connected to the GSM modem, the data from the PLC is sent to the government's website using the port-forwarding technique of the modem. The modem consists of a GSM antenna that is used get the maximum signal so as to send the data from the PLC to the government's website. The sim card used in the modem is of service provider IDEA (any suitable service provider can be used). [4]

V.RESULT AND DISCUSSION

The system works efficiently and the data is transmitted without any loss. Accurate measurement of the required parameters is possible because the sensors used are of very high quality and accuracy. This system can be assembled and installed in the least amount of time. These qualities coupled with its high efficiency will make this system very desirable to the clients.

VI.DRAWBACK

The remote locations of the dam sites sometimes cause the modem to not receive a signal which prevents the data from being sent to the government's website. But the GSM antenna can be installed on higher altitudes to reduce this problem. When a battery is used to power this system, after a certain time the battery will drain. Hence to keep the system functioning, a battery charger is required to maintain the battery power.

VII. FUTURE PROSPECTS

Since this system is very accurate and easy to interface, it is predicted to have a tremendous demand in the near future. Other important qualities are its compactness and the ease of installing it in any suitable location gives the system certain flexibility like no other. The accuracy of the system is in keeping with the government's requirements. Hence this system is predicted to have a lot of demand when it enters the market.
Along with the system, instead of a GSM modem, the PLC has the feature of communicating with a Computer using a RS485 to USB converter. Thus, software can be developed for Data Logging purpose. The rainwater level and the dam level readings can be stored and compared. Using graphical method, this data can be well represented.

VIII.CONCLUSION

Dam automation is made successful using this system. The readings from the sensors are very accurate and the overall response of the system is very fast and good. This project can be deemed successful because it provides the necessary data required by the government.

REFERENCES

[1] Flexys Panel TX4, Datasheet, Selec Controls
[2] RLS- Radar Level Sensor, Datasheet, OTT Hydromet
[3] TB4- Tipping Bucket Rain Gauge, Datasheet, Hydrological Services Pvt. Ltd.
[4] GoRugged M1000 XP- GSM Modem, Datasheet, Robustel Technologies