Design and Implementation of Water Environment Monitoring System using GSM Technology

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***Abstract* – A dam is a barrier that impounds water or underground streams. Dams generally serve the primary purpose of retaining water, while other structures such as floodgates or levees (also known as dikes) are used to manage or prevent water flow into specific land regions. When the water level in the dam exceeds certain level, the dam is in danger of collapsing. To avoid this, we should constantly monitor dam water level so that dam structure does not give way under the pressure of the water. This can be done by controlling the flood gates if the water level exceeds certain limits. Also water being a scarce resource, it becomes necessary to preserve and maintain its quality. In order to do so, various water related parameters should be under constant check and evaluation. The main water pollution related parameters that need to be monitored are Temperature, Turbidity and pH. This paper explains the theoretical aspects related to the project we are doing and the details regarding the demonstration of the automation of dam gates.**

Keywords– ZigBee communication, GSM Modem, AT89rdv51 Microcontroller

I. INTRODUCTION

The control mechanism of the dam gates are done manually and using PLC. But there are lots of errors in manual method. Also the PLC based system is huge and hence suitable for major dams due to its cost. For medium and small dams like irrigation dams does not require such huge PLC systems. So to reduce these problems a mechatronic control system is proposed in our project.

This project is an AT89rdv51 microcontroller based dam gate control system which helps in keeping an eye on the frequent usage of water resources from 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 proposed mechanism of dam gate control reduces the water wastage and efficient usage of available water is ensured.

The water level is detected based on the feedback from the mechanism used. In the case of major dams, nearly real-time structural monitoring of the dams can reduce the loss of human lives or properties and in the case of small irrigation purpose dams, real-time monitoring can help in reducing the damage caused to the crops by giving an indication when the water level in the dam exceeds a certain threshold and depending on the water level of the dam, gates can be controlled. In addition to the automation of the dam gates, a predefined SMS will be sent to all the concerned officials when the water level crosses the highest mark. Along with these water level sensors, sensors to measure various pollution related parameters are present. Environmental variables like temperature, turbidity and pH are also measured in order to get an accurate picture of the dam properties. When the range of these values crosses a certain undesired threshold, a predefined SMS will be sent using a GSM modem to all the concerned officials so that they can take the necessary actions.

II. LITERATURE SURVEY

Floodgates are adjustable gates used to control water flow in flood barriers, reservoir, river, stream, or levee systems. They may be designed to set spillway crest heights in dams, to adjust flow rates in sluices and canals, or they may be designed to stop water flow entirely as part of a levee or storm surge system. Floodgates sometimes are also used to lower the water levels by allowing more water to flow into a flood bypass or detention basin. In addition to spillways, openings through dams are also required for drawing off water for irrigation and water supply, for ensuring a minimum flow in the river for riparian interests downstream, for generating power, and for evacuating water and silt from the reservoir. These gated openings normally are fitted with coarse screens at the upstream ends to prevent entry of floating and submerged debris. Provision for cleaning these screens is essential.

In the paper by Srikanth Anumalla[1], wherein at numerous locations in Nebraska where groundwater level monitoring systems are deployed, water level is usually measured using pressure transducers. Someone periodically drives to these locations to download data from these sensors on to a computer. The downsides of this process arethe delay in availability of the data and the costs. Commercial solutions to this problem use radio spectrum or cellular technology to transfer the data to a remote location. The huge costs involved with the installation and use of these technologies are a major limitation for their use in realistic scenarios. In this project, they proposed a new system for sensing the groundwater level data in real-time using Field Programmable Gate Arrays and Wireless LANs (IEEE 802.11). The main objective of their project is to demonstrate the proposed system with a low-cost prototype implementation which can acquire, transfer and display (or archive) groundwater level data from remote locations.

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In 1986 Davidson, E.G.[2] proposed a control system for efficient working of hydroelectric power plant with the help of Visual Display Units (VDU's).This proposed VDU system guided us in making a GUI for monitoring purpose. A paper was proposed by Xavier Litric[3] to use SIMO systems for water management in dam. This SIMO system deals with the real time calculation of the upstream and downstream flow of the water in dams. By observing these factors and accordingly operating the gates can be carried out. The system we proposed can be merged with the above mentioned system for effective operation of dam gates. Marcel Nicola, Florin Velea[4] have proposed a system for effective control of Hydropower Dam Spillway using PLC/SCADA system. But recently Montanhydraulik[5] manufacturing company has installed a PLC based control system for controlling the operation of dam gates. This system was successfully installed on a large scale in foreign countries and the only dam in India where this system is installed is Indira Sagar Dam in Madhya Pradesh. But this PLC based system is costly and effectively applicable formajor dams and not for small and medium dams like irrigation dams.

Slivnik, T. Kodric, M.; Antauer, M. proposed a protection unit[6] for the dam gates which overcame some drawbacks of other existing system like not detecting anomalies, such as asymmetric movement of gates, faults in drive gearwheel etc. In our paper we have provided the limit switches for proper movement of gates. So we can use their system with our system to overcome other anomalies too.

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III. SYSTEM DESIGN

In our project, we are using microcontroller (AT89V51), GSM modem, Xbee module, power supply, stepper motor, water level sensor, temperature sensor, pH sensor, turbidity sensor and ADC0808. In a very simplistic form, a micro-controller system can be viewed as a system that reads from (monitors) inputs, performs processing and writes to (controls) outputs. The output of the water sensor is digital output. Hence the ouput of this sensor goes directly to the microcontroller. Whereas the output of the other sensors are in analog form. Therefore we need to convert these analog values into digital values before connecting to the microcontroller. ADC0808 is used for this purpose. These values will be sent by a transmitting XBee module to a computer for monitoring purpose. A GUI like Visual Basic is used in our project for displaying the values on the computer. A receiving antenna is connected to the computer to receive values from the site. If the values received are above a dangerous level then a SMS will be sent through the GSM modem. Also, the gate of the dam is controlled automatically by the microcontroller depending on the water level reached.

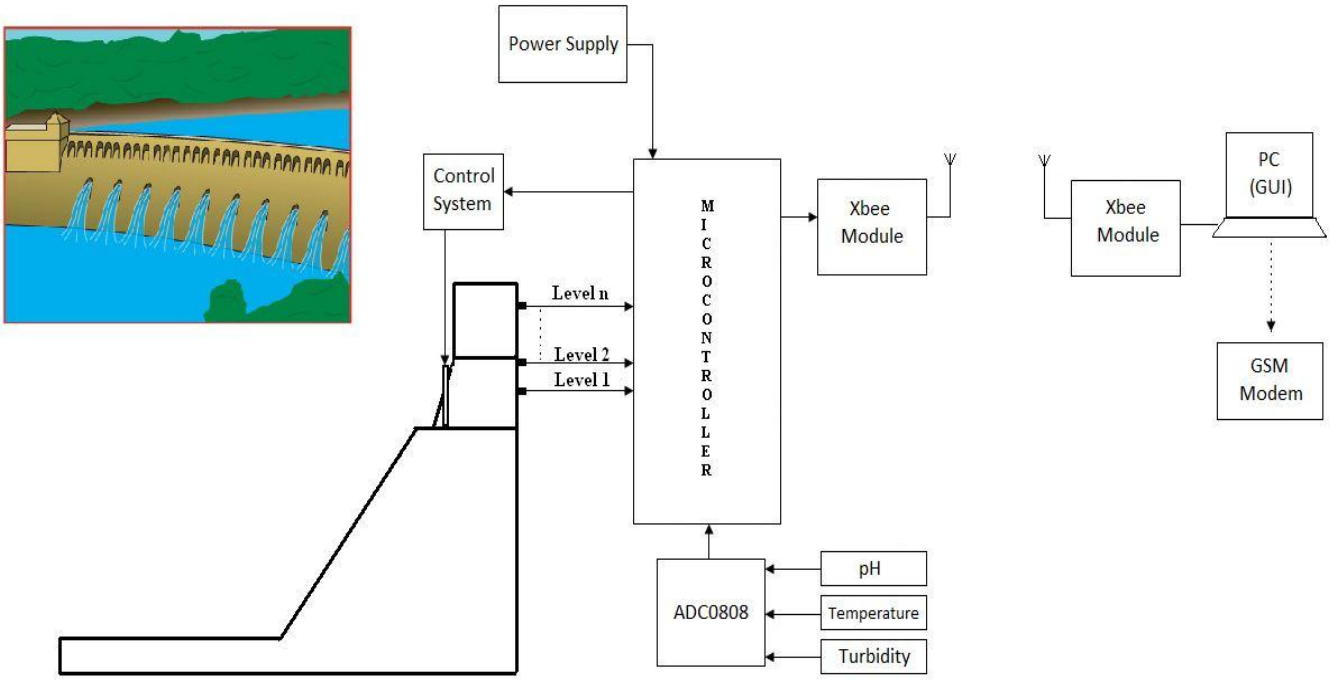

Fig.1.System Block Diagram

To solve the problem related to collapsing of dam due to storage of water beyond its capacity, we have proposed to automate the flood gates. We will be fixing water level sensors on different levels on dam walls. When the water reaches these levels, these sensors will send signal to the microcontroller. The microcontroller will then execute the predefined instructions stored in it. This predefined instruction deals with opening of flood gates. When the water level reaches the first level, the gates will open and go up a certain height. When the water level reaches the second level, the gates will further move upwards. In the same way by the time the gate reaches the final level, the gates will be opened completely. When the water starts receding, the gates will start closing up. Also, the sensors for the other environment parameters will continuously send the values to the GUI through XBee module. GUI used in our project is Visual Basic. It will display real time values of different parameters and also which level the dam water has reached. We have set threshold levels for all the parameters. When the values exceed the threshold levels, a message level will be sent through GSM modem to the concerned officials. A predefined message will also be sent when the gates are opened.

IV. DETAILS OF HARDWARE

A. Micro controller (AT89V51)

In this project work we are using AT89v51 micro-controller. This micro-controller plays a major role. Micro-controllers were originally used as components in complicated process-control systems. However, because of their small size and low price, Micro-controllers are now also being used in regulators for individual control loops.

B. Analog and Digital Converter

ADC0808 is used to convert the analog values from the sensors to digital values. The temperature, pH and turbidity sensors provide with analog values whereas the water sensors give digital values, hence they are connected directly to the microcontroller. ADC0808 requires an external clock. The maximum clock frequency that can be given is around 164kHz. We chose to give a clock frequency ok 100kHz. This clock frequency is achieved by using RC oscillator with a NOT gate which works as a Schmitt Trigger.

C. Water Sensor

We use CD4066B which has four quad bilateral switch each with independent controls. Each switch will be connected to particular predefined levels. As water reach these levels, the microcontroller will control the dam gates.

D. Temperature Sensor

LM35 is used which is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in ^{o}C). LM324 is also used which is an operational amplifier with true differential inputs. LM324 is used to amplify the electrical output received from the temperature sensor before giving it to ADC0808.

E. Turbidity Sensor

The turbidity sensor consist of a light sensitive device i.e. a photo-resistor (LDR) and a power LED. The LED and the photo-resistor are fixed at a short distance apart in such a way that water can flow between them. The more turbid the water, the less light from the LED lamp will reach the photo-resistor. As water turbidity increases, less light will reach the photo-resistor, and resistance increases.

F. pH Sensor

pH sensor measures the pH value and converts it to voltage signals. The pH is measured using a pH electrode. This electrode the converts the pH value into corresponding voltage value. This voltage level is the amplified using operational amplifier, TL062. Since the pH electrode was expensive, for demonstration purpose we have directly given in the voltage value to the ADC.

G. Stepper Motor

The gates present on dams work on the principle of hydraulics. For demonstration purpose, we are using a stepper motor and a wooden gate. The gates will be controlled depending on which level the water has reached.

H. XBee Module

The parameter values from the sensors at the dam site are send to the GUI at the concerned personnel's office using XBee Module. Two modules are used, one as transmitter and the other as receiver. The transmitter module is connected to the microcontroller at the dam site and the receiver module is connected to the computer in the office. The real time monitoring is done using a GUI on the computer. The GUI used in our project is Visual Basic.

I. GSM Modem

GSM module is used to send SMS alert when the parameter values cross the threshold levels. The modem isconnected to the computer. The SMS alert is sent via the GUI from the computer.

V. RESULTS AND CONCLUSIONS

The system successfully provides real time monitoring of the turbidity, water level, temperature and pH. Sensors for measuring various pollution parameters like pH, temperature, turbidity were successfully implemented. Transmission and reception of data from the sensors to the GUI using XBee modules is demonstrated. Automation of flood gates when the water level of the dam exceeds the predefined threshold values is also demonstrated. A predefined SMS using GSM modem is sent when any of the monitored parameters goes beyond the range..Hence by using this monitoring system we can have real time monitoring of various parameters and depending on these observations the concerned authorities are alerted to take the precautionary measures. The thresholds for the various parameters are given below.

Table. I. Parameter Analysis

Parameter	Threshold	Outcome if Parameter above Threshold
Temperature	50	Temperature is high
Turbidity	1.5	Water is turbid
pH	5-9	Water is acidic or basic

FUTURE SCOPE

In our system, only when the dam reaches the predefined levels, an alert message is send as well as displayed on the GUI. For a more efficient system, thecurrent water level can also be displayed on the GUI. Oursystem is though proposed only for the proper control ofgates but further it can be extended for proper supply ofwater for irrigation and to households too by implementingadditional system. Also a WSN network can be developedcomprising of a number of nodes, where in through routingof data a larger area of the reservoir can be covered. Anadditional number of parameters such as conductivity,dissolved oxygen in water can also be measured.

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