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Water Level Monitoring and Dam Valve Control over IOT

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Abstract: ***This project gives an outline for the development of an information system based on the existing systems with the utilization of some sensors and IOT. The cradle of this project is based on methodology of IOT. Water level in a dam needs to be maintained effectively to avoid complications. The quantity of water released is hardly ever correct resulting in wastage of water and it is impossible for a man to precisely control the gates without knowledge of exact water level and water inflow rate. We have developed a mechatronics based system. We have designed a system in which real time things are interconnected to web. Water level contactless Ultrasonic sensor is placed in tub connected through Arduino UNO to serve the same purpose automatically and forward the status to it. This system detects the level of water and estimate the water inflow rate in a tub and thereby control the Solenoid valve using IOT in a real-time basis. The water level is analysed using this sensor and updated in the web server using IOT module connected to the Arduino UNO. Arduino unit checks that input and upload the status of water level on web.***

Keywords: IOT (Internet of Things), Mechatronics, Ultrasonic sensor, Arduino UNO, Solenoid valve.

I. INTRODUCTION

In India, nearly 4000 major/medium dams are constructed and many more are in a pipeline. Normally, the range of dam storage capacity is of 185 billion cubic meters of water with a surface area of 5,580 km (93.4 TMC ft). During rainfall, for every 9.6 mm, the rise of water level increases by 0.3 ft.

In the recent analysis by the BC dam safety annual report, from the year 2011-2016, number of dam incidents, dam alerts and dam failures are decreased respectively. With the growing interest in Internet of Things, it has become a right choice for the pre-alert system for monitoring the rise in the water level in dams and controlling its gates.

During rainy season, floods are very natural to occur. But if they occur heavily then problem will arise. Through this project, we have built an automatic protection system for dams through IOT based water monitoring and controlling techniques.

We required Arduino UNO microcontroller to interface with the water level sensor, valve, Wi-Fi model, etc. We placed the sensor above the tub.

We programmed the microcontroller in such a way that whenever the sensor senses the water, the value of the water level will be updated into the remote server accordingly. Once the water level hits the mark of 85%, immediately the valve gets opened automatically and buzzer warns for sometime. The valve remains open till the water level is reduced below 85%.

We here propose an automatic dam water level monitoring and gates controlling system over IOT. Our proposed project uses sensor to sense the water level and then opens the valve according to the water level in tub. Thus, our proposed system allows for automatic valve opening and closing based on water level sensing.

It also proposes a novel idea of collecting and sharing real-time information about water levels to an authorized central command center through far field communication. Authorities can view this information using internet from any place.

Also, the purpose of our project is to monitor the water level in dam using the advanced concept of IOT employing Arduino UNO. It is about developing an automated system for monitoring and controlling the dams remotely.

A. Proposed System

In the proposed system, water level monitoring in tub is done with the help of non-contact Ultrasonic sensor and the current status is sent to the Arduino UNO over IOT. We have designed the system in which instead of gate, solenoid valve is used which gets opened automatically when water level rises high. Buzzer gives high alert when the water level is at risk. Current status of water level and valve can be seen on Mobile or PC. The proposed system offers more flexibility over existing systems.

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II. REVIEW OF LITERATURE

Various efforts have been made up till now in monitoring water level & accordingly controlling dam gate. The contribution of work in this area is mentioned below -

A. IOT Based Water Supply Monitoring and Controlling System

The setup has a water tank, which is filled with the help of a tap. The pipe is connection to solenoid valve or flow control valve and water flow sensor. The Raspberry Pi controls the solenoid value by turning it ON and OFF. If the solenoid valve is set ON (ON signal sent by Raspberry Pi), the water flow through the valve else if it is set OFF (OFF signal sent by Raspberry Pi), the solenoid valve stops the water flow. After this, the water flows through the water flow sensor. This sensor is a turbine which will turn 3600 for every time of water passed through it. If 1 litre is passed, it rotates 3600. If 2 liter passes through the water flow sensor, the turbine rotate 6400. This rotation valve is read by ACD unit which will turn forward the digital value to Raspberry Pi. The ADC unit converts the analog data into digital data and sends to the Raspberry Pi. The Raspberry Pi in turn to store this data in MySQL database. There are 2 databases, one is uses database and other is authority database. It can be used to generate bill for the amount of water used. The values of the amount of water passed is passed to the CLOUD (THINGSPEAK). Since in any unexpected event of crash or destruction of the setup or software, the values or data is stored on the CLOUD. Hence, the cloud is used for security and safety purpose. There is a PH sensor attached after the water flow sensor which checks the PH value and decides if the water is portable (suitable for drinking). If the water is not portable, the sensor doesn't release the water further. A soil sensor is also attached after the PH sensor which will check for any soil in the water. All the data is collected with a Raspberry Pi and it process continuously and push data onto the cloud. We are going to collect the data from sensors, flow sensors are connected to analog to digital converter. Water flow sensor consists of a plastic valve body with a water rotor. It uses a pinwheel sensor to measure how much liquid has moved through, water flows through the rotor rolls, speed changes which outputs the corresponding pulse signal. Flow rate is measured in Liters/sec/min/hour. By counting the pulses from the output of the sensor, we can easily track fluid movement. The Global Positioning System (GPS) is the fully functional. Global Navigational Satellite System will help in determining the location, speed/direction and time with the assistance of 24 medium Earth orbit satellites. Here, in this project, we use this for locating the position or place. Local database is installed in the SD card of the Raspberry Pi and data is collected and stored. From the cloud, we can monitor and control the water flow. We can also generate plots using data collected. The data collected there is also used in reverse analysis using python programming [1].

B. Automatic Gate Control and Water Level Reservoir using Zigbee Technology

This project focuses on the use of multiple sensors as a device to check the level of water quality as an alternative method of monitoring the condition of the water resources. The wireless sensor network based on Zigbee technology is developed to solve the defects of existing parameters monitoring system. In the wireless system, all the data will be transmitted in wireless method. The environment data from temperature sensors, pH value sensors, tachometer and ammoniacal nitrogen sensors will be collected in every network node and transferred to monitoring center. Since the real-time measuring data could be transmitted to monitoring center via Zigbee network and GPRS network, the operation staff will only sit in the office to check up the system running state [2].

C. Wireless Disaster Monitoring and Management System for Dams

A Zigbee based system is proposed for disaster monitoring and management. It talks about wireless monitoring of water levels of group of dams and due to drastic change in water level in any river/lake, when to open the gate of which dam and upto which limit. It is decided with the help of sensory data collected from different nodes, placed over an area. The system comprises three parts, sensor nodes, local control room and centre control room. The monitoring is done with the help of data collected from sensor nodes (comprising water level sensor and rain sensor) and discharge sensors are used to control the opening of gates upto certain limit. All the decisions are taken through centre control room, by giving commands to different local control rooms after observing conditions of all areas. A hooter is also available with local control room node to indicate danger alert if water level crosses danger level [3].

D. Dam Gate Level Monitoring and Control over IOT

The main objective of this system is to control the water level in dam which is implemented using IOT (Internet of Things). The design implementation and control of the programmed monitoring system is developed by this project. For best results, the principle operation of the automatic gate control arrangement is subjected to dry running under various possible circumstances, with Proteus as the platform for working [4].

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E. Raspberry Pi Based Automatic Dam Monitoring and Alert System

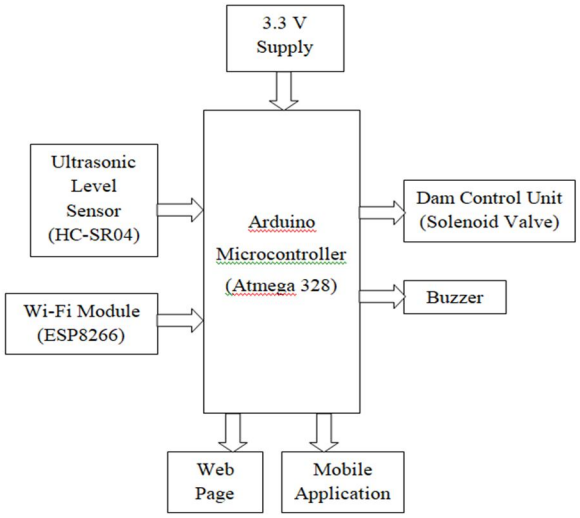
It deals with the automatic control of a dam river system. The system is a cascade of single input-single output (SISO) systems, and can be considered as a single input-multiple output (SIMO) system, since there are multiple outputs given by intermediate measurement points distributed along the river. A generic robust design synthesis based on internal model controller (IMC) design is developed for internal model based controllers. The robustness is estimated with the use of a bound on multiplicative uncertainty taking into account the model errors, due to the nonlinear dynamics of the system. Simulations are carried out on a nonlinear model of the river. The industry has always focused to devise engineering methodologies for establishment and modification of relatively easier controlling and automation methods for any scrupulous process. To verify the principle operation of the controlling design to be presented, a miniature automated dam model is experimentally tested using a PC-based system [5].

F. IOT Based Water Level Monitoring System for Lake

In this system, they have introduced the idea of water level monitoring and management for lake water storage source for villages. More specifically, they have introduced the Raspberry Pi as controller for water level sensing and controlling in a wired and wireless environment. Furthermore, it can indicate the amount of available water in the lake. This system is based on GSM technology. Moreover, cellular phones with relative high computation power and high quality graphical user interface became available recently. From the users perspective, it is required to reuse such valuable resource in a mobile application. Finally, it has proposed a web and cellular based monitoring service protocol for monitoring available water in lake [6].

III.METHODOLOGY

A. Block Diagram



B. Working

1) *Arduino:* In this project, we are making the system by using Arduino Microcontroller named Atmega 328 over IOT. Power supply required is 3.3 V. Arduino is used to control the overall system automatically that reduces the design of system and control complexity. It will take input from the sensor unit which will sense the water level through level sensor. When water level will rise or decrease, then the sensor circuit will trigger the Arduino. If level will rise high, controller will receive the command and perform the action of controlling devices. Controller will control the valve and Buzzer.
2) *Ultrasonic Level Sensor:* The contactless Ultrasonic water level sensor HC-SR04 is used for sensing water level accurately. It will give the output to Arduino.
3) *Wi-Fi Module:* ESP8266 Wi-Fi module is generally used to establish the wireless communication between the devices. Collected sensed data will be forwarded to web server through Wi-Fi module. Arduino will send the signal to the valve whether to get opened or closed through this Wi-Fi module.
4) *Solenoid Valve:* It will be fixed in dams instead of gate. It will be opened or closed automatically according to the level of water. Once the water level reaches the 95%, it will be automatically opened. The valve will be opened till the water level is reduced below 85%. It will be controlled by the Microcontroller.

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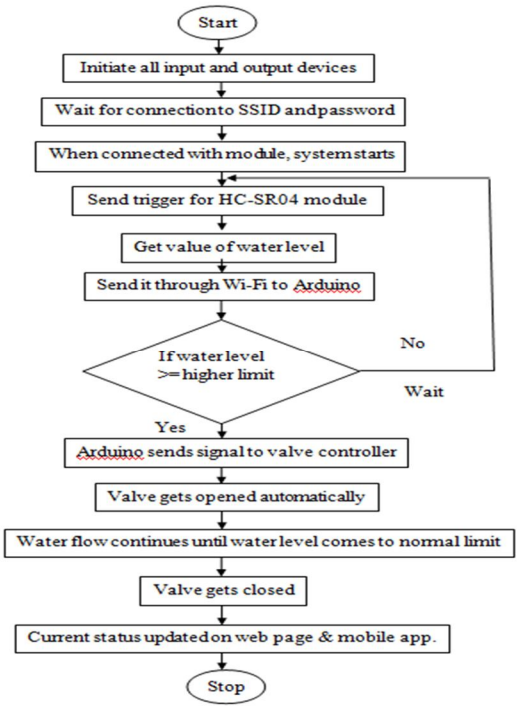
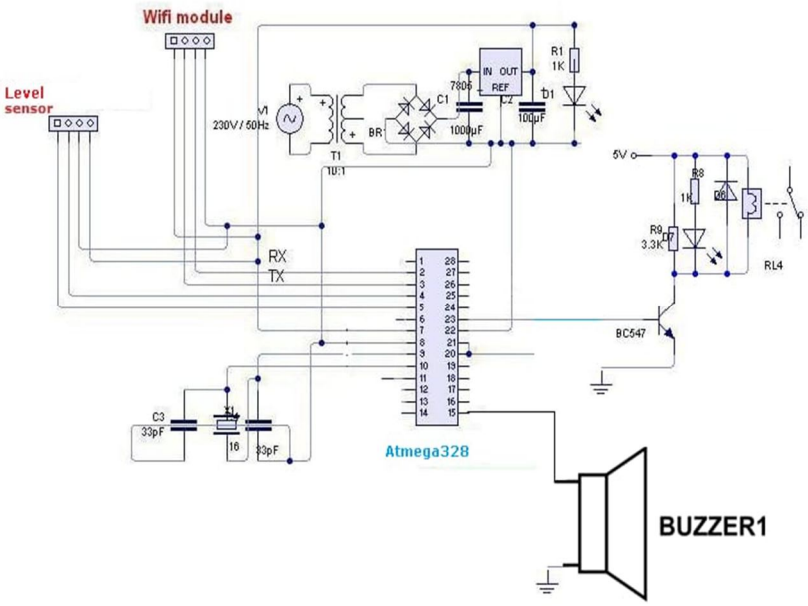
5) *Buzzer:* It will turn ON for particular time period when the water level reaches to dangerous limit. Arduino will send signal to it accordingly.
6) *Power Supply:* Power supply required is 3.3 V to the Arduino. Power will be given to other components.
7) *Web Page:* The water level indication and valve current status, i.e., whether it is ON or OFF will be uploaded on the Web page.
8) *Mobile Application:* All the data regarding present valve status, water level will be updated in the Mobile application.

C. *Flowchart*



D. *Circuit Diagram*



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E. Explanation

When the connection is established between the Arduino UNO and Wi-Fi module, the green LED on the circuit board glows. This is a signal of connectivity of the device through hotspot. Transformer takes 230 V primary power supply and gives output of 12 V AC. It is a step-down transformer which gives 1 A current. This input is given to the circuit board which is reduced to 5 V DC as required by the microcontroller using rectifier circuit made up of 4 diodes in4007. For pure form of DC, filtering capacitors are used. 7805 voltage regulator which is a three terminal IC is used to regulate the voltage level from 12 V to 5 V. First pin of the IC is input, second is ground and third is output. Then the 5 V supply is given to the Arduino UNO microcontroller IC, Buzzer, LED and to trigger the relay. Wi-Fi module operates at 3.3 V DC so to change its voltage level, the same voltage is also supplied to LMT17 adjustable voltage regulator. It will adjust the 3.3 voltage level whereas it can adjust from 1.5 V to 32 V actually. To adjust the voltage level, variable resistor is used. When this variable resistor is changed, voltage level gets adjusted. It has been set to 3.3 V. This voltage level is given to Wi-Fi module. There are 8 wires connected to Wi-Fi module of which I used 5-6 wires which are VCC, ground, RX, TX, security enable. VCC and ground are connected to voltage regulator. RX and TX are connected to second and third pins of microcontroller IC respectively. To give pull high to them, below two pins, two extra pins are added. So there are total 4 pins extra. Security pin is pulled up using resistor. LED is used to indicate the successful working of all the components on the circuit board. Buzzer beeps for some time to indicate the level is high. Relay is used to ON/OFF the valve which requires 12 V DC supplied by SMPS (Switched Mode Power Supply) which takes 230 V input. Relay is used for the operation of Solenoid valve. One terminal connection from the microcontroller goes to IC (Optical Isolator) of relay to insulate the relay to microcontroller. Crystal is the heart of controller which is used to make the controller ON. We have used it of 16 MHz. When the crystal is ON then the controller is ON. It starts communication. According to the program, initially, we connect to SSID and password. Microcontroller will communicate with the Wi-Fi module over the RX and TX to establish the connection with SSID and password. Then Wi-Fi (Wireless communication) is connected to the hotspot of the device (Android Mobile), LED becomes ON. Then the program sequence of loop gets executed. Trigger will be sent to Ultrasonic sensor of 10 microseconds. Then the distance will be identified which will be sent to microcontroller and then the microcontroller decides whether to open the valve or not.

IV. FUTURE SCOPE

This project is useful for large dam systems to control the overflow of water. In future, you can control the valves from any place of the world. Improvements can be made with minor changes in this model by eliminating the operator and providing the complete control to microcontroller (automatic level controller). By doing so, the operation of dams all over the country will be centralized and automated. The massive water level increase will be noted, accordingly valves will be opened and pre-alert caution for the stage wise water level increase to the public through social media will be taken. Thus, you can warn public by using the growing technology to protect the livelihood of people in that habitat. We can do modifications such that people will get the message on Twitter by using GSM model and also we can add E-mail sending facility. So, dangers can be informed in time to nearby people. Thus, saving lots of lives avoiding unpleasant scenarios. Also, we can develop a system where we can do Data Mining according to future requirements. We can design the more advanced Mobile App. and Web Page which will show the graphical representation of the water level indication, messages and E-mail notifications and having other important features. Thus, there is much scope to this system and we can expect much more from it.

V. CONCLUSION

We have successfully completed this project. Thus, we conclude that by this project, each and every variation of water level is informed to web server through internet. We are replacing contact sensor with contactless sensor. Also, instead of gate, solenoid valve is used which gets opened automatically when water level rises to excess limit. We have implemented this fully automated system using small tub to represent the working of such system in dam. So, with it, this prototype or model is ready which is completely a new system and soon this system will be used in actual dams with real or practical functioning on a large basis, initially, may be in small dams.

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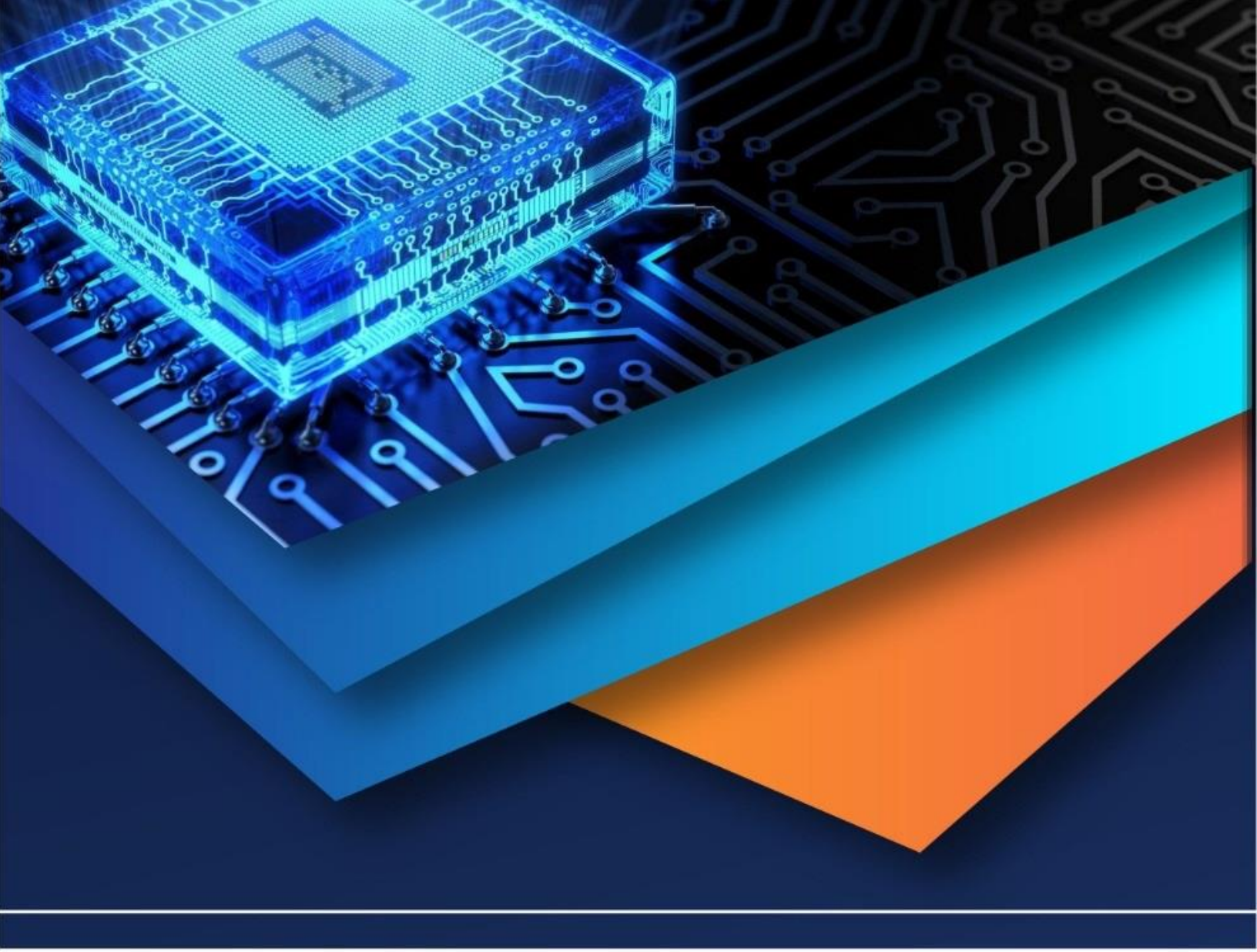

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