Designing of IoT Based Dam Gate ControllingSystem for Mitigating Failure due to Flood Conditions

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Abstract

Dams are a huge source of water supply for any city and many people depend on the water supplied by dams forfulfilling their basic requirement of water. However just as much helpful dams are, they are also responsible for huge losses of life and infrastructure. Gates of dams have to be opened up during heavy rainfall which leads to flooding in villages situated downstream. If timely warning is not given, this could lead to widespread devastation. To prevent this loss, we need an automatic gate control and warning system. Internet of Things (IOT) has become an indispensable solution for uploading the data on cloud and accessing it. This paper presents implementation of automatic controlling of the Dam gate using NodeMCU interfaced with float sensors. The proposed system is use in automatic operation of the dam gate. The quantity of water in tank is calculated according to the area of dam and position of float sensors interfaced. IOT is being used for uploading the status of dam gate and also a text message is sent using the Twilio software, for precautionary purpose. This proposed system intimates regularly via internet to the authority and villagers about any changes in data of dam level for eluding unpleasant. The total time taken by the gate of our model to open fully is 323seconds and the time taken to upload the data and to send the message to the registered mobile number is approximately 20 seconds, once the water level reaches first sensor.

Keywords : *IoT, Water Level Monitoring, Stepper Motor,Float Sensor, Dam gate Control*

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I. INTRODUCTION

Dams are the major sources of water supply to cities. They play an important role in controlling flood like situations and can assist river navigation. Hydro power plants requires communication between the metering systems and computer for support and management. Complications can be avoided can be avoided by proper maintenance. With the enormous increase in human population, there has been an exponential increase in urban residential areas, as more and more space is being occupied by humans [1]. This increase in urbanization has led to crucial issues that affect the quality as well as quantity of water, along with the problems of water distribution, interrupted water supply, water conservation and water consumption. Hence there is a need to overcome problems related to water supply.

We need to make an efficient system for proper monitoring and controlling. It is absolutely necessary to monitor the level of water in dam to ensure safety and optimal operation. As of 2021, India has approximately 5,264 completed major and minor dams and 437 dams under construction [2]. In most cases today, water level monitoring is done manually by a full-time operator. However, this mostly leads to waste of water as a result of inability of the operator to accurately determine the quantity of water to release from the dam gate. There is an added issue of loss of data in real time due to time lag between transmission of the results of manual observations and decision making. IoT has been a great influence in water monitoring and controlling system field. By the use of microcontroller interfaced with different sensors, it is possible to not only monitor data but also analyse it and use it to control the system. In this paper, we wish to propose a system to automatically control the dam gates when the

water level rises and decreases. The system is also implemented and tested. In the past years, efforts have been made to conserve water and make an efficient dam gate control and flood detection system. In research paper based on water level monitoring and management of dam gate using IoT [3], [9] - [12], a draft for an information system using IoT interfaced with sensors. For safety, real time collected data of water level is shared with authorized person, after that they will decide on opening of gates or not. By this all the operations will be centralized.

In the next research paper, An IOT based Water Supply Monitoring and Controlling System with Theft Identification [4], continuous and real time monitoring of water supply in IOT platform is focused on. The amount of water in tanks, flow rate and abnormality in distribution line is also recorded. The authors have used Raspberry Pi interfaced with different sensors like flow sensors, Turbidity sensors and GSM module, to monitor data and control the operation of the system. They have used Adafruit library to show real time monitoring and operation of data. In Survey on IoT Based Water Monitoring and Controlling System [5], IoT and Remote Sensing (RS) techniques are used for collection, monitoring and analysis of data. The data used in this research was taken from different remote locations. Various different models for continuous and real time water monitoring systems have been developed along with different microcontrollers that can be used to for implementation.

In Real Time Controlling as well as Monitoring of dams using IoT [6], the authors have proposed an idea for automatic collection of data of water level in dams. This collection of data would help in controlling of dam gates. The main objective of the paper is to reduce manpower and automate the dam gate control process and dam maintenance.

The authors have also implemented the proposed idea using IoT, Thing Speak and different sensors interfaced with Arduino and XBee Module.The objective of Dam Water Level Monitoring and Alerting System using IoT [7] was to integrate IoT to build an system to alert the public when there is a rise in water level. The ultrasonic sensor data is collected periodically over time and analysed to observe the rise in water level.

In Water Level Monitoring and Dam Gate Control over IOT [8], a system has been designed to interconnect real time things with the web. This system consists of level sensor interfaced with Raspberry Pi. The sensors will analyse the water level and this data will be updated on cloud by using Raspberry Pi. The gate will be controlled manually by respective authorities after analysing the data. Papers [14] -

[20] are based on different models of liquid level monitoring systems based on IoT which are used in different sectors of industry.

From the review of the above literature survey, an existing system and its drawbacks can be defined. Some of the drawbacks include that some models used a lot of hardware which is harder to implement in real time specially near a dam that consists of water that can damage the hardware. We have used minimum hardware that would be required, as well as used NodeMCU that is cheaper than Raspberry Pi that has been used mostly. Using NodeMCU has given adequate results and made the system cost effective as well as simpler to handle. We have used Twilio Software instead of hardware like Gsm module hence reducing the hardware and make it easier to implement. The system proposed is flexible and the sensors can be adjusted as per the area of the dam.

This paper is organized into three sections. Section 2 describes the proposed system and design of the system. Section 3 discusses the implementation of the system with a dam prototype. Section 4 is the conclusion of the work done.

II. PROPOSED SYSTEM

Our proposed system consists of various components like float sensors, NodeMCU and Stepper motor. The proposed system will use Node MCU interfaced with the float sensors. The float sensor will sense the level of water in the dam and the information about the water levels will be updated on the Cloud. A flood warning will be sent to the villagers via a text message to reduce the damage to life and infrastructure. This can be done by registering the phone numbers of villagers on Twilio Software. Our system will also control the opening and closing of dam gate according to the level of water. When the level of water will rise above the first float sensor, the inherent circuit gets complete and

the dam get will open partially. According to the level of water that has increased, the gate will open. And, as the water level start decreasing the gate will start closing automatically. When the gate will startopening up, a flood warning will be sent to nearby villages using twilio and also get updated on Thingspeak , so that theycan evacuate in time and the number of casualties can be decreased. System will immediately change the direction of gate for sudden changes in water like rapid hike in water level. Our propose system can be easily implemented and definitely useful for preventing the damage caused due to floods and other harms like rapid changes in water level of dam. Hence water level monitor is one of the important task for this system. By gathering data from water level monitoring sensor, regular intimations can be send on serverand if nay major changes is observed then system will itself intimate the admins and authorized users. Based on that alert specific action can be planed like opening of dam gate, how much gate should be open, etc. . Figure[1] shows the block diagram of our system.

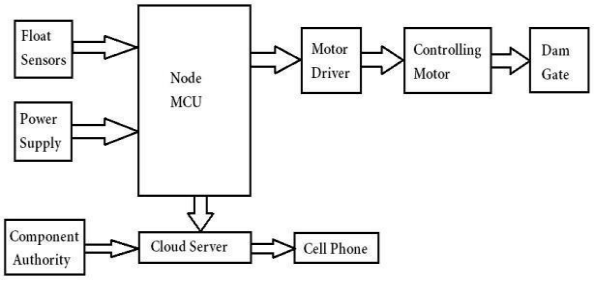

Figure 1: Block Diagram of automatic dam gate control.

III. SYSTEM DESIGN

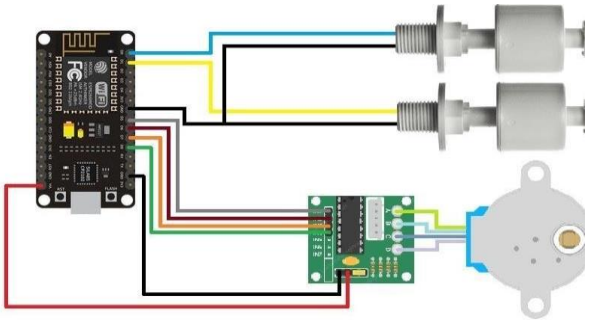

Figure 2 Circuit diagram of automatic dam gate control systemwhich shows the sensors interfaced with Node MCU and controlling motor.

To test the efficiency of our proposed system we have implemented a small dam prototype. We have used two float sensors interfaced with stepper motor, when the water level rises up to sensor 1, the float rises towards the stem and completes the circuit. Motor starts to rotate according to steps defined and the gate starts to open slowly and water is let out.According to the dimensions of the dam model, the number of sensors can be increased and the motor will rotate and open the gate further. The data is updated on Thing Speak as the gate opens. A message is being sent via Twilio software to the registered number when the gate is opened. When the water level rises to the first sensor the gate opens slowly to 50% of its height as we are using only two sensors. The required number of revolution is 600 for lifting up the gate to50% i.e. 12 cm in our case. When the water level will rise to the second sensor then remaining gate will open i.e. the 12 cm. As the level of water will start decreasing simultaneously the motor starts rotating in anticlockwise direction which in turn will start closing the gate. When water will reach the sensor level, data will be updated on cloud and also a text message will be sent to registered numbers.

IV. WORKING FLOW OF AUTOMATIC DAM GATE CONTROL

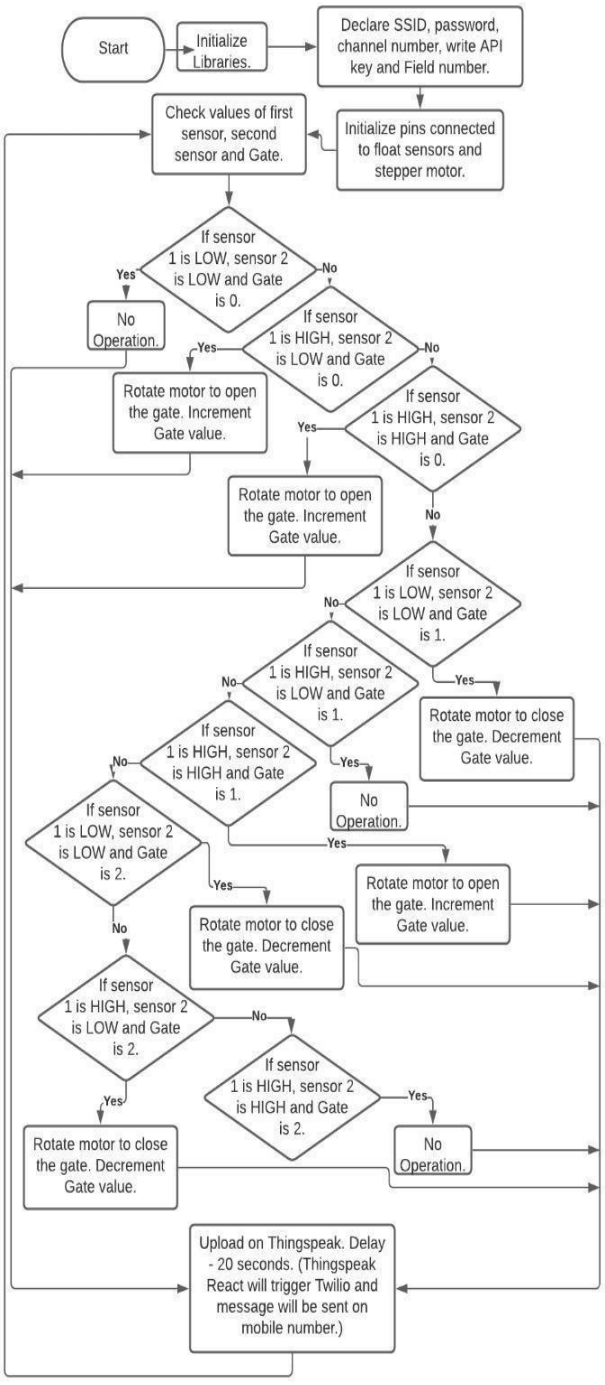

Figure 3: Flowchart of automatic dam gate control system.

V. IMPLEMENTATION:

For the successful implementation of this proposed idea, we have used Arduino IDE Software to write the main code. We have additionally used Thing Speak and Twilio Software's toupload the real time data and send a flood warning to nearby villages respectively. The float sensor was attached to the dam model at different levels of height to sense the level of water. A stepper motor was used to mimic the control of opening and closing of the dam gates. Different phone numbers were input into the system for the broadcast message test. Figure (4.a) is of the dam model having sensors and stepper motor interfaced with NodeMCU. As we will pour the water, when water reaches the level of sensor one the motor will rotate and start to openand it will rotate only for predefine revolutions. Figure (4.b) shows water being let out of the gate. As mentioned above when the dam gate is open (after the water crosses level of first sensor i.e. 50% of tank height), the data is uploaded to thing Speak, which triggers a React, which is connected to Twilio. Twilio in turn will send SMS to all the subscribed numbers regarding the DAM gate being opened, so people can be on alert.

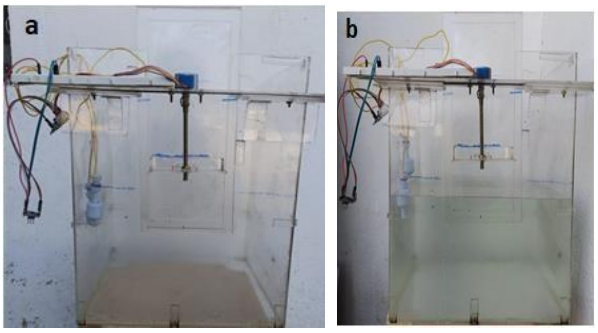

Figure 4 (a) Dam prototype of proposed system (b) waterlevel reaches upto sensor

Figure 4.a and 4.b shows the dam prototype of proposedsystem. In figure 4.a the dam prototype is shown with sensorsinterfaced with motor and without water.In the figure 4.b the dam is filled with water.The water level in the dam prototype is reached up to the sensor 1 of automatic dam gate controller.

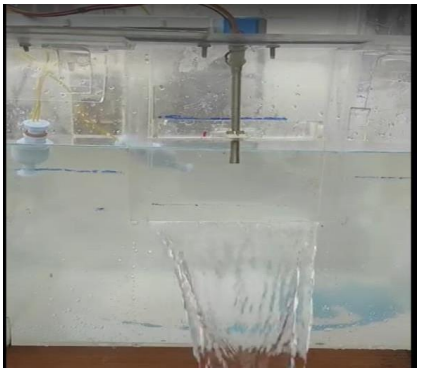

Figure 5 Water flowing through gate ofdam prototype.

VI. RESULT AND DISCUSSION:

We have successfully implemented the project and achieved the desired outcomes. We have used the float sensor in our model that works as a switch and when the float part of the sensor is lifted, circuit gets completed and the stepper motor starts rotating. The data about the level water is constantly uploaded on ThingSpeak which triggers a react that is connected to Twilio, which in turn will send a flood warningto nearby villagers on their registered mobile numbers. The thingSpeak will also generate a graph that can be used for analysis purposes. The number of revolution of stepper motorneeded to open the gate halfway or upto the first sensor is 10,000 and time taken to open gate halfway is 165 seconds. The total time required to open the gate fully when water level reaches above second sensor is 323 seconds. Once the water level reaches the first sensor, the total time required to uploading the data and sending the message via Twilio is approximately 20 seconds. Figure 6 shows the data being uploaded on cloud using Iot and a text message is sent to registered mobile is shown in figure 7

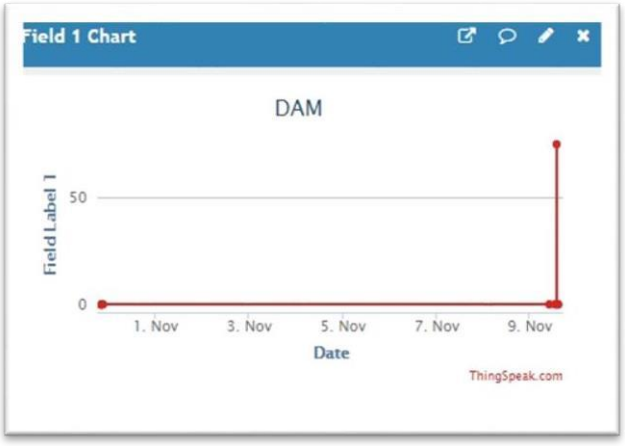

Figure 6 : Data of the automatic dam gate controller beinguploaded on cloud

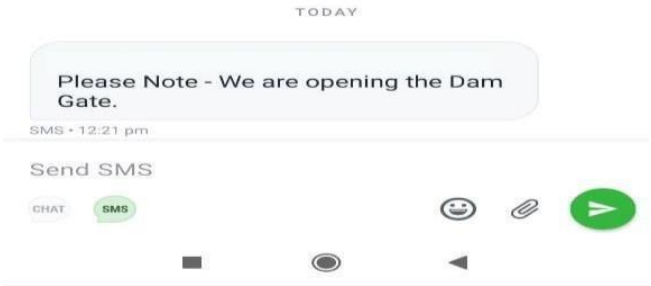

Figure 7 Text message received to registered mobile number.

VII. CONCLUSION

Dams are a major source of water supply in most cities and villages. But they are also capable of immense destruction to life and infrastructure if the water levels are not managed properly. We have presented a technique to control and monitor the water level based on IOT using float sensors, Node MCU and stepper motor. The dam gate can be controlled using stepper motor. This system helps in monitoring variation of water level through thing Speak platform and nearby villages can be informed in due time. The controlling motor requires 10,000 number of revolutions for the gate to open halfway or upto the first sensor and takes upto 165 seconds to open gate. The data requires 20 seconds to be uploaded on cloud server and for the flood warning message to be sent via Twilio. This small period of time is very helpful in avoiding unpleasant scenarios as people can evacuate in time. The proposed system is reliable, efficient and useful for dams. Field monitoring can be avoided by using proposed system which will indirectly reduce the manual work of data monitoring and collections. System is efficient, accurate, low cost and reliable.

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