Automation of Water Reservoir Using IoT

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Abstract— Water reservoirs are nothing but the dams. These dams provide us with a wide range of social, economic, environmental benefits by helping us in controlling the flow of water, navigational purpose, flood control, industries, irrigation and act as habitat for aquatic life. India has progressed a lot in the construction of dams and water reservoirs after independence and many more are already under the process of construction. But even today most of these dams use the conventional methods of dam management for controlling the dam gates and dam maintenance. The growth of Internet of Things (IOT) paved the significant attention in all fields. The objective we propose in this paper is the application system with integration of IOT to ensure the safety to the public about the prior alerting of flood occurrence due to increase in the water level in dams or reservoirs. To achieve the objective cloud database technique is maintained which holds the periodic monitoring water level data. The sensor data is collected periodically that are uploaded to the cloud database where the automatic comparison analytics about the increase in water level is noted. Thus, the prior stages of rise in water level are automatically alerted to the public respectively. Finally, it was observed that the level of accuracy is grown by this technique in comparison with ordinary method of monitoring and alerting system.

Keywords: Reservoir, Dam, Internet of Things, Level Sensor, Google Firebase

I. Introduction

We have so many rivers, lakes and ponds in our country. Agriculture is the main backbone of the Indian economy and availability of water is the prime need for agriculture. Hence dams and water reservoirs play an important role in the sustenance of the economy in the country. We have many states in our country and each state has its own set of dams to conserve water for its usage. All these water resources like rivers, lakes flow through different states before they join the sea. But in the time of natural crises like draught and flood the main problem occurs which is that conflict of interests arise between the states which share the water bodies and the situation has become intense in the recent years. Every state tries to complete its need of water without considering about the need of others. It may also lead to water wars between states. One thing we can do to tackle this issue is by centralizing the control of all the dams under a single command centre. Till now we are using the same conventional method for controlling the dams and measuring the level of water except for few dams which use the automatized techniques for monitoring. There is necessity of creating some sort of connection between the measuring systems and the control mechanisms of the dams. This can be achieved by the use of Internet of Things (IOT) can be interpreted as a network of devices connected together through a communication channel and can be used to gather the data, analyze the data, and act accordingly. A set of sensor are used to collect the data about the level of water and this data can be relayed to a command centre using communication channels and the command centre interprets the data and sends commands back to control the dam.

The integration of Wireless Sensor Networks and IOT with cloud communication enhances the operation capabilities to a great extent as most of the data is transferred through the cloud and this allows us to relieve the data and issue commands with more reliability. This has the potential to automatize the complete functioning of the dam with minimum human interference. We can also extend this system to all the dams in the country that means we will have the data of water levels of all the rivers throughout the country at one place so we can reroute the flow of water using this data as per the requirements in the country. This is also useful in active flood control as quick decisions can be taken regarding the diversion of flood water. If the level of water at one place is alarmingly below a minimum level then water from other places can be diverted to the required place with minimum delay. This system can also be extended to keep a check on the safety of the dam. In this we can use pressure sensors to check the impact of water pressure on the walls of the dam which helps us in ensuring that the walls are strong enough to withstand the flow of water. We can also use differential pressure sensors to assist in dam maintenance. The sensors will be placed at equal intervals on the pipelines and if there is any leakage or breakage, a pressure drop can be identified at the sensor near the leak. So the maintenance staff can be alerted regarding the issue and measures can be taken to fix it quickly. We can improve the surveillance of the area around the dams by installing cameras which can send the footage from the area around the dams. This can be used to do a quick check of the surroundings before releasing the flood water which will avoid a lot of mishaps.

II. Literature review

One study was carried out on the Nile River. As we know that Nile is the longest river in the world, this type of study is best suited there. The project teams have installed geo-referenced databases through the length of the river. They also installed spatial layers consisting of hydro-meteorological parameters, usage information, hydrographic features, land cover, land used, and type of soil. New age monitoring techniques like automatic weather monitoring stations and acoustic Doppler current profiles were also installed. These are the most cost effective systems for water flow measurement. Usually the Doppler effect of current profiler is portable and is installed in a boat or float without the need for an expensive cable setup. The team also installed a couple of buoys on Lake Nasser to get an estimate regarding the ground reality related to satellite based evaporation assessment. All the basin countries have adopted this type of data structure after interaction with the respective resource agencies. Having such a common data structure eases the process of data sharing and fastens the entire process.

Water level monitoring is an active area of research and a lot of people are examining the possibility of using fuzzy or neural networks for controlling water level in control system. Artificial neural networks (ANN) give us fast and flexible means of creating models for river flow prediction and these models are known to have performed at par with the conventional methods. An artificial neural network can be viewed as networks of nodes connected together just like the neurons in the brain. Each node (dam) of the network represents a neuron and an arrow represents the transfer of information from one node to another. We can characterize the normal structural behavior of the dam by studying the kind of actions the structure was subjected to in the past.

In 2016, Divya Kaur presented a paper on "IOT based Water Tank Control System" for prevent the water wastage. Making a control system to automatically control the water pump requires careful observation of what people do as their daily activity to make sure that the tank is full. In almost all over India every state has a State Water Supply body which is responsible for development and regulation of water supply in state. Due to scarcity of water the release of water is controlled and done at certain times in a day. So this paper is aimed at presenting the project in embedding a control system into an automatic water level controller using wi-fi module.

In 2015, Thinagaran Perumall, Md Nasir Sulaiman, Leong presented "Internet of Things (IOT) Enabled Water System". They implemented "water monitoring system using IOT" for real time scenario. This resolution is of low cost which includes system of integrated sensory that permits inner observation for quality of water. Using Internet, relevant and warning data are transferred to a cloud server and these data can be received by user terminal which are owned by consumers. The water measurements and result is shown on cloud. A Thing speak as a segment of alert system is integrated also. This type of organization can give early alert system for portable water quality.

III. BASIC SCHEMATIC

The basic idea of this system is to completely automate the process of dam control with the use of wireless sensors networks and Internet of Things (IOT). We will have three main bodies in the implementation of this system. The first one being the level sensor setup, second being the local base station and the third one is the central command centre.

Simple level sensors using transistors can be used for measuring the level of water near the dam. These sensors will be placed under the dam on certain predefined levels. These sensors will be interfaced to microcontroller which will read the level of water and relay the information to the local base station (Fig. 1).

The local base station is generally situated near the dam and receives the data of water level from the sensors. This data is aggregated and then sent to the central centre through cloud. Each dam will have one base station and each of them will upload the data to the cloud which can be retrieved by the central command centre (Fig. 2).

The central command centre accesses the data from the cloud and analyses the data. If the level of water at a dam is below the threshold limit then it sends a command to the base station of that dam through the cloud to close the gates to store the incoming water. Similarly if the level of water is above the upper threshold value then the command centre sends a command to open the gates. Then the local base station reads the command sent by the command centre from the cloud and then acts accordingly. We have not used just one sensor to decide the threshold limit but number of sensors at different levels So that we can decide the threshold limit according to the storage and necessity of water. Also we can get the exact level of water by placing number of sensors. The entire process flow is shown in Fig. 3

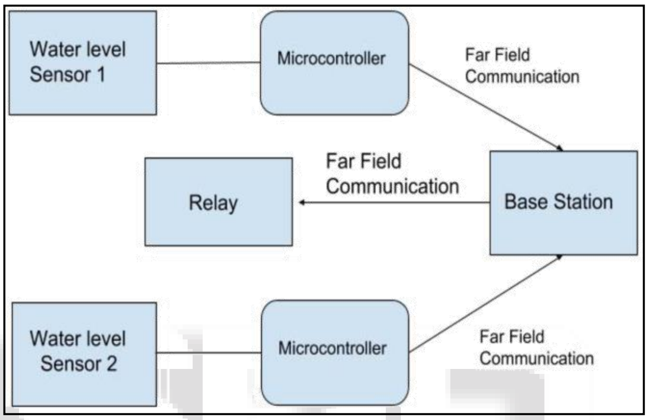

Fig. 1: Schematic of single node

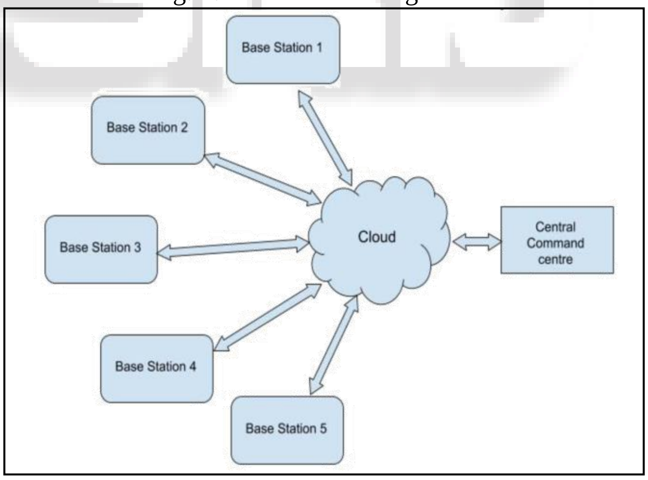

Fig. 2: Schematic of collection of nodes

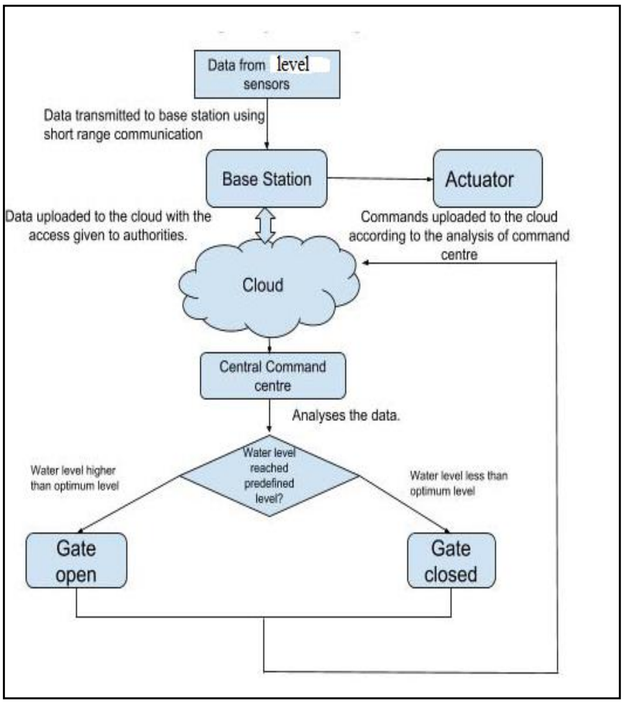

Fig. 3: Flowchart of the implementation

IV. Methodology

A. Determining the level of Water

Level sensors using transistor can be used to measure the water level. It is interfaced with the microcontroller. When the water touches the metal contact in which base of each transistor is connected, small current flows and turns on the transistor (Fig.4).

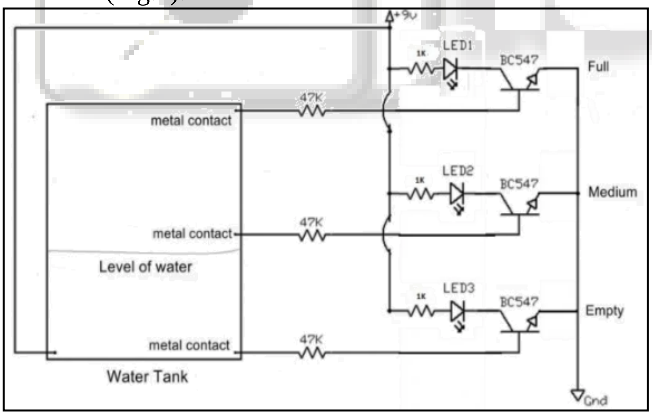

Fig. 4: Level sensor setup

When a transistor turns on, LED connected to it glows and a signal goes to the controller as these sensors are interfaced to the microcontroller. And each transistor shows its predefined level. Controller will read the level of water and relay the information to the local base station.

B. Short Range Communication

We need a communication method to transfer information between the sensor and the local base station which is nothing but node MCU. As we have used transistorized sensors, there is need of more number of IO pins. Also pins are needed for LCD display at each dam, so with node MCU we are going to use a separate controller which is AT89C51. Sensor data is directly connected to the controller with copper wires. Then controller data need to be sent to the local base station as it is having Wi-Fi chip which is required for further communication. Since the sensors are installed under the dam the range required for communication is around one to two kilometers. For such short distance it's better to use serial communication method. AT89C51 and node MCU both are having TX and RX pins they are connected with cross connection.

C. Long Range Communication

We need to transfer the information to the central command centre from base station. The distance between each base station and central command centre can range from few hundred to thousands of kilometers. We are using node MCU kit v0.9 which has inbuilt ESP8266 Wi-Fi chip. It can monitor and control things from anywhere in the world. There is 128 KB RAM and 4MB of Flash memory for program and data storage just enough to cope with the large strings that make up web pages and everything we throw at IOT devices nowadays.

The ESP8266 integrates 802.11b/g/n HT40 Wi-Fi transceiver, so it can not only connect to a Wi-Fi network and interact with the internet, but it can also set up a network of its own, allowing other devices to connect directly to it. This makes the ESP8266 Node MCU even more versatile.

As the operating voltage range of ESP8266 is 3V to 3.6V, the board comes with a LDO voltage regulator to keep the voltage steady at 3.3V. It can reliably supply up to 600mA during RF transmission. We have to go with the cloud based implementation because of its cost effectiveness and ease in availability. ESP8266 module serves us best in this case as it is a combination of microcontroller and a Wi-Fi microchip. The Wi-Fi microchip can be used to connect to any mobile hotspot which establishes the connection to Internet.

The local base station aggregates the information from all the sensors and uploads the data to the cloud server in real time. The central command center analyzes the data and takes a decision to open or close the gate. This command is now uploaded to the cloud and the local base station reads it. The local base station then operates the actuator related to the dam gates based on the command received. We use the Google Firebase platform for the cloud communication. Google Firebase is an IOT analytics platform which provides us with secure channels to upload the data and access it from anywhere in the world. In this methodology we also need to use some internet module to upload the data to the cloud.

V. Prototype Design and Implementation

A prototype of the proposed application has been implemented using Level Sensors, AT89C51 microcontroller, Node MCU consisting of ESP8266 module, Google Firebase server and servo motor. The first stage of implementation which involves determining the level of water is achieved using level sensors. The water level sensors are mounted under water container (Fig. 5).

Fig. 5: water tank with level sensors and pumps

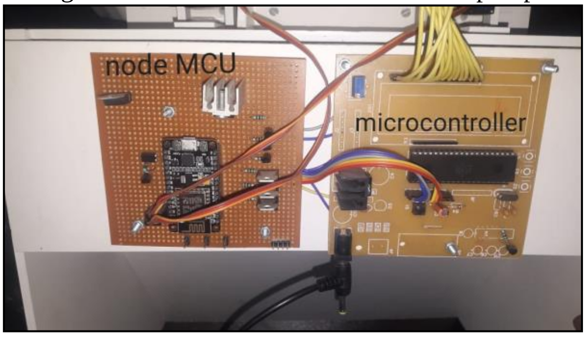

Fig. 6: Node MCU and microcontroller

The water level data is transmitted from microcontroller to the local base station through serial communication which provides short range communication. The Node MCU with ESP8266 module acts as the local base station (Fig. 6). The Node MCU consists of a microcontroller and Wi-Fi microchip. The ESP8266 module gets the data from microcontroller and uploads it to the Google Firebase server. We can check the data from time to time on the Google Firebase platform.

Another Node MCU acts as the central command station which reads the data from the Google Firebase server and analyses it. It decides whether the gate is to be opened or closed. It sends the commands in binary to the server. It sends a command “1” if the gate has to be opened and “0” if the gate has to be closed. It has the optimum level of water set at a value above which it changes its command. The command is read by the Node MCU which acts as the local base station and it controls the servo motor based on the commands received. If it receives “1” then it turns the motor in anticlockwise direction signifying opening of the gate and if it receives “0” then it turns the motor in clockwise direction signifying the closing of the gate.

VI. RESULTS

To run the system, we have activated all the nodes involved that is water level sensor setup, local base station, and central command centre. The level sensors are continuously working and providing the current water level readings. The local base station uploads the data to the Google Firebase cloud (Fig.7).

In figure two pictures are added one is of low status and second is of high status. We can see three parameters in both pictures that are dam level, pump status and gates status. In first picture the water level is high so the pumps are on and gates are also opened. In second picture water level is low so the pumps are off and gate are closed.

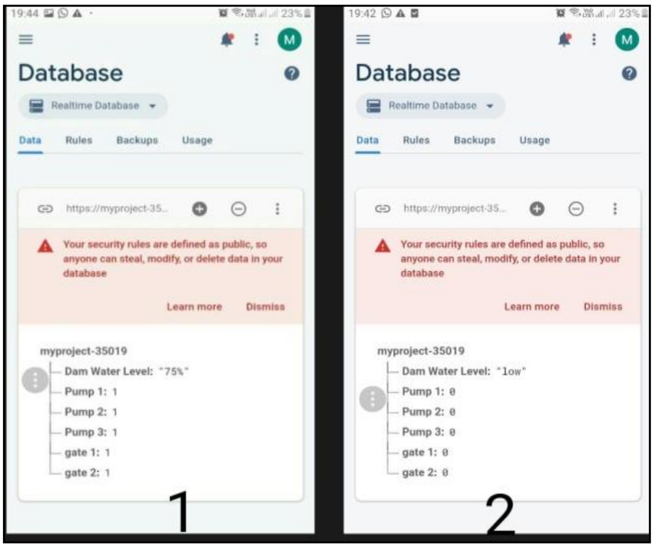

Fig. 7: Firebase data

The data uploaded to the cloud is read by the central command centre and it analyses the data. It checks the level of water, analyzes it, and sends the command accordingly. When the water level goes beyond the optimum level it sends the command to open the gate

VII. FUTURE WORK

We can make the data collection more extensive and collect data related to dam strength using Pressure sensors. We can also use differential pressure sensors to check if any pipelines near the dam are damaged or leaking, this helps in the maintenance of dams. CCTV footage can also be added to the data to transfer the information about the surroundings of the dam before releasing the water. We can create a network of such dams operated centrally and control the moment of water from anywhere to decrease the effects of floods, and distribution of water to different states on need basis.

VIII. CONCLUSION

Currently water level monitoring systems are used on a small scale in tanks and ponds. Those who have already implemented also have short comings. In this paper we tried to suggest a large scale implementation of the water level monitoring and management of dams. This fully automated system is cheap, flexible, easily configurable, and solves the water distribution problems between different states. This system also results in saving a lot of manpower which can be put to good use elsewhere. We have suggested the use of an IOT for automating the dam control by using wireless sensor networks, short/long range communication modules, and cloud. The prototype design has been successfully implemented. Further research work can be carried out in this area to create a full-fledged real world dams monitoring and management system.

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