WATER LEVEL MONITORING AND MANAGEMENT OF DAMSUSING IOT

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ABSTRACT

The history, culture, current and future socio- economic status and environmental sustainability of India and its people are intricately linked to the water resources which are available from dams. These water resources available through dams are one of the main sources available for the usage to industries, livestock, irrigation etc. and there is a critical need to ensure the safety of the water level at these dams against any natural or anthropogenic threats and to develop an effective Water Level Management system using IoT. This paper gives an outline for the development of an information system based on the existing systems with the utilization of some sensors and IoT. This paper 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. The authorized central command center then takes a call whether to release the water by opening dam gates or keep them closed. By doing so, the operation of dams all over the country is centralizedand automatized.

Keywords*: IoT, Dams, Authorized handler, LPWAN and NB-IoT*

INTRODUCTION

Dams are the major sources of water supply to cities, they also play a vital role in flood control and can assist river navigation. Most of the dams are built to serve more than one purpose and their benefits are manifold. It is necessary to implement some sort of communication between the metering systems and computer models to provide support in managing the complex systems of the hydro power plants. Generally, the dams are monitored through traditional surveillance techniques and the water management except the monitoring of level of water in some of the dams which is automatized. Management of water resources through dams becomes complex as the number of users depending on dams is huge and these users may have conflicting interests. This situation gets much complex with the fact that the available resources are limited with high possibilities of droughts and floods. This affects the densely populated areas (1-2). Dam monitoring is a tedious and long term process which has to be improved step by step. A new system for dam water monitoring and management should be established which can provide water level in real time and can allow us to come to quick conclusions regarding the safety operations of the dams. Internet of Things (IoT) can be defined as a network of devices which are interconnected. It comprises a set of sensors, communication network as well as software enabled electronic devices that enables end users to acquire accurate data from time to time through the communication channel and allows for data interchange between users and the connected devices (3).

This system can be used to automatize the control of dams without human interference. This can also be used to gather information on the level of water throughout the country and can be used to route water based on the requirements. We can get information on the water availability in a particular region and route the water to that area if there's scarcity. This helps a lot in irrigation.

Keeping a check on the safety of dam from time to time is one of the important measure to ensure the safety of dams. Use of Wireless sensors network with software for dam safety management helps in improving the functionality of dams. All the sensors in the cluster of dam such as Water Level Sensor ,Vibration Sensor and Pressure Sensor can be used to sense Water level ,Vibrations on the wall of dam and Pressure exerted on the wall of dam from the dam into the main pipeline in Litres per minute respectively (4). Differential Pressure sensors are fitted at equal spaces along the main pipeline which can sense the pressure difference because of the breaking or leakage of the pipeline and will immediately be communicated to the observer. In case of floods the routing of flood water can be done more efficiently considering the level of water across different dams. Surveillance of areas near the dams can be done using cameras which transmit live footage to the base station and will be helpful in identifying the presence of people near the dams and can help in ensuring safety while releasing water during flash floods. Internet of Things technology focusses on making the ecosystem of sensors more and more intelligent by establishing a connection to the internet. Collecting the data regarding the failed sensors enables us to generate more reliable equipment which in turn improves the reliability of the dams. Integration of Internet of Things with big data, cloud computing and WSN will enhance the operation capability to dams to a greater extent (5-6). The entire processing of data will be done on the cloud which will ensure that the data retrieval and issuing of commands can be made faster with more reliability.

BASIC SCHEMATIC

The basic idea of this project is to fully automate the water level management near all the dams through a central server [7]. This can be achieved by the use of IoT linked cloud services applications. At first each dam is considered as a single node. Many such nodes are linked to a central command centre which can oversee the working of each and every node.

At first the setup near the primary node i.e, (dam) consists of ultrasonic sensors on the either side of the dam gate. These ultrasonic sensors are useful to get the real time level of water on both the sides of the gate. Every dam has a local base station from which the data on level of water can be transmitted to the central server. The ultrasonic sensor has to be interfaced with a micro controller through which information is relayed to the local base station. For this we need to use far-field communication methods as the minimum distance between the transmitter (near the sensor) and receiver (near the base station) will be at least 1 km. In this way the data from both the water level sensor reaches the local base station (Fig 1-3). After gathering the information from both the water sensors, the base station sends the data to the central command centre via cloud. The data from each base station is uploaded to the cloud and the central command center can check the real time water level using this data and can decide whether the dam gates have to be kept open or closed. All the dams will have base stations like these which gather data and transmit data to the cloud. So the command center has the real time data of all the dams across the country (8).

After getting the data from each primary node the work of command center is decide whether the dam gates have to be opened or kept closed or vice versa. For this a pre-defined water levels have to be formulated i.e, below a certain threshold water level the gates of the dam have to be closed and above a threshold water level the dam gates have to be lifted. These defined water levels vary from node to node depending on the amount of water that dam can hold or the requirement of water at that particular area. Now after the decision to open or close the gate has been taken, this has to be sent as a command to the base station. So the command centre transmits the command to the base station and the base station in turn transmits the data to the gate control which opens or closes the gate based on the command. The flowchart depicting this entire process is being attached (9).

IMPLEMENTATION

A. *Determining the Level of Water*

In the first stage we plan on getting the data on the level of water using ultrasonic sensors. The ultrasonic sensors are interfaced with a micro controller which transfers the data to a local base station using far field/near field communication. Components required: Ultrasonic sensors, Arduino.

B. Short Range Communication

In this stage we deal with transferring the data at shorter distances i.e., at a local base station. The distance might range from few hundred meters to one or two kilometres. The short data transfer modules like Bluetooth or XBee are interfaced with the Arduino and used to transfer the data. Components required: Bluetooth module / XBee module.

C. Long Range Communication

In this stage we work on transferring the data to long distances of order of several hundred kilometres. These helps us in gathering the data from all the nodes to a central base station which in turn reads the data and send the commands based on it. The technologies required to achieve this are yet to be finalized. Some types of communication which can be used for such purposes are LoRa , NB-IoT.

- LoRaWAN is a Low Power Wide Area Network (LPWAN) intended to provide long range connectivity for wireless battery operated Things in a regional, national or global network. LoRaWAN meets the key requirements of Internet of Things such as secure bi- directional communication, mobility and localization services [8].
- Narrow Band IoT (NB-IoT) is a category of Low Power Wide Area Network (LPWAN) technology standard developed to enable a connection using cellular LTE bands between wide range of devices and services. NB-IoT is a narrowband radio technology designed specifically for the Internet of Things (IoT) applications. NB-IoT focuses primarily on indoor coverage, low cost, long battery life, and enabling a large number of connected devices [9].

PROGRESS

A prototype of the proposed idea has been implemented using short range communication (Bluetooth modules),Ultrasonic sensors and Arduino micro controller. The first stage of the implementation which involves determining the level of water using water level sensors. The water level sensor is mounted on the top of a water container which determines the distance between the top of the container and the surface of the water. If the distance goes below a certain point it indicates that the water level in the container has exceeded optimum level. The pictorial representation of the setup is shown in fig 4.

The water level data is transmitted to the second Arduino board through Bluetooth module. The readings received by the micro controller are shown in Fig. 5. Two nodes send data simultaneously to the central command centre. The level of water from both the stations are received one after the other at the central station. If the volume is increasing, then the level of water is increasing and when it is about to reach the max capacity of the container a signal is sent to the servo motor. The second micro controller which operates the servo motor interprets the input data and when the level of water is more, it switches on the servo motor which will be connected to the gate mechanism. As soon as the level of water decreases the second micro controller will not send any command to operate the servo motor hence the gate mechanism is closed. The prototype implementation of short range controlling is done as above and the long range communication is under progress.

APPLICATIONS & USES

The above mentioned method will ease the process of water level management on a large scale. We can solve many water related issues by this method. By installing a central command center we are decreasing the manpower required at each and every dam. Since this is a fully automated project, any kind of human intervention has been avoided. So the possibility of faults has also decreased. In cases of emergency, the override capability will be given to an authorized personnel who can change the command if required. In places where there are issues of water distribution between two areas, this method helps in maintaining neutrality as the command is with the central command center and neither of the areas involved in the fight can give the command. During times of natural disasters like floods, this method will be very helpful as we don't need to have any human to control near the actual site of the dam. Any command required for the gate opening or gate closing can be given from remote center. This also reduces the response time as the water level data near command center is real time and the decisions are taken almost instantaneously. Since the data of water levels near all the dams throughout the country are at the same place, a quick decision on the routing of flood water can also be taken. This helps in decreasing the losses due to floods to a significant extent.

CONCLUSIONS

Water is one of the primary resource for human survival. But unfortunately a mammoth amount of water is being squandered by uncontrolled use. There are certain automated water level monitoring systems in practice but they are used for various applications and have some shortness in practice. We tried to suggest ways to tackle this problem and implement an efficient water level monitoring and management system. The main motto of this research work is to establish a flexible, economical and easy configurable system which can solve our water distribution problem between two regions and safeguard the low lying areas from floods etc. among many other issues. We have been using a micro controller to manage the data and to reduce the cost. We have been successfully conducting the experiments in lab and therefore proposed a cloud based water level monitoring and management network whose flexibility would offer us to control the system from any place via access to cloud data with different type of devices. This type of system is more helpful in situations like floods where the automated gate lifting system will check the water levels and react according the situation. This could have a substantial benefit to the research work related to the efficient management of water at dams by reducing the manual work.

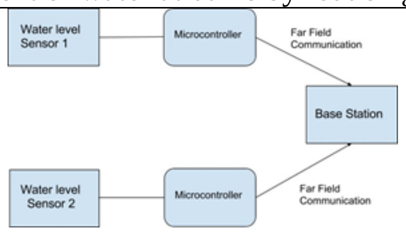

Figure 1. Schematic of each node

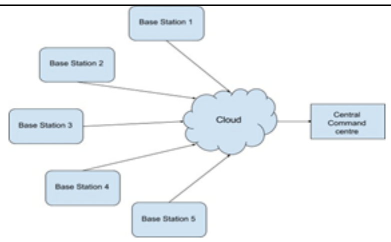

Figure 2. Schematic of the collection of nodes

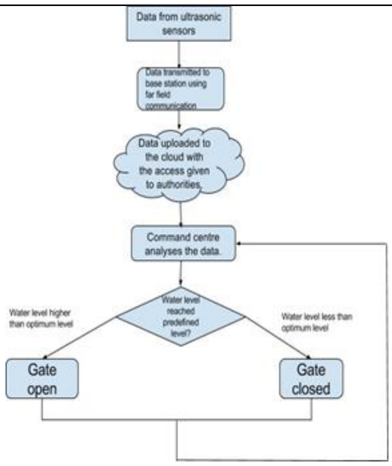

Figure 3. Flowchart of the implementation

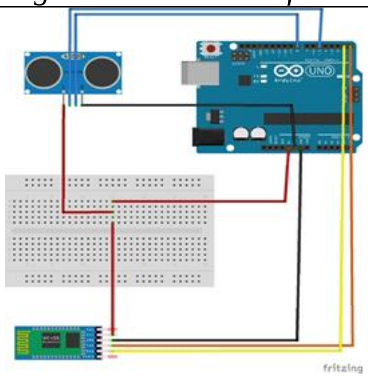

Figure 4. Setup of water level sensor

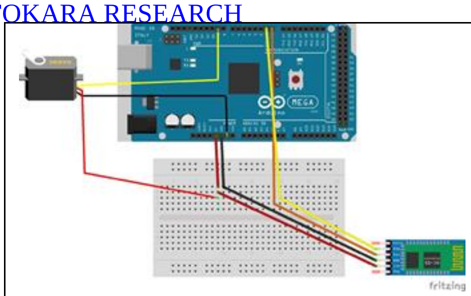

Figure 5. Setup of the Servo motor controlling gate mechanism

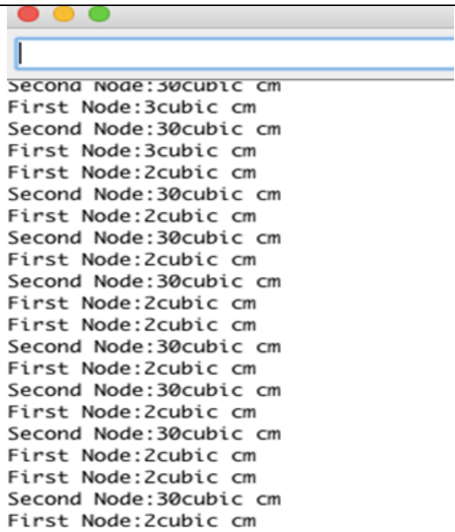

Figure 6. Readings of the Ultrasonic Sensor

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