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Dam Monitoring and Water Control System using Machine Learning and IoT

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***Abstract*— The main source of water for a country like India which is having climatically vivid temperatures in different regions is the dams. These water resources available through dams are one among the most sources available for the usage to industries, livestock, irrigation, etc. and there's a critical got to make sure the safety of the water level at these dams against any natural or anthropogenic threats and to develop an efficient Water Level Management system using IoT. This paper gives an overview of the event of a data system supporting the prevailing systems with the use of some sensors and IoT. This paper proposes a unique idea of collecting and sharing real-time information about water levels of different water bodies that refills the dams to a licensed central command center through an ML model that analyzes the data collected and determines the next action taken. The call to whether the release of the water then can be taken based on the recommendation by the ML Model. By doing so, the operation of dams can be centralized and automated which can lead to better management of Flood control across the country.**

Keywords—Water Level Management, Internet of Things (IoT), Dam Monitoring, Machine Learning, Dataset Handling, Data Collection.

I. INTRODUCTION

Dam plays a serious role in our life as they're used for purposes like irrigation control and mainly generation of electricity. There are approximately 4200 major/minor dams in India. When it comes to dams, there are various parameters to be measured [1]. Most of the regions in India face flood like situation due to overflow of dams and sudden opening of doors to prevent the leakage. This sudden outburst can be prevented if we monitor the in and out water flow from the dam continuously.

The idea proposed is to install IoT devices in all the water bodies surrounding the Dam that provide their water to the dam. These water bodies can be big like rivers or can be smaller ones like ponds and lakes.

Also the water level and flow speed of these water bodies will be monitored along with the dams water level. If we notice some anomaly in these readings we will be informing the Dam engineers about it and will warn them about any conditions.

We have classified the alerts into 3 different categories:

1. Danger
2. Warning
3. Alert

1. Danger:

This is the signal with the highest priority of Danger. Receiving a Danger signal indicates that the Dam is now overflown and there is no more room. The gates need to be opened in some specific time. It might be linked with an emergency SOS message to all the nearby peoples to vacate the place immediately. This signal is only sent when there is a prediction of Flood like conditions.

2. Warning:

These signals are sent to Engineers only when the condition is worsening continuously and there is a need to take immediate action to prevent the mishap. It might represent a condition when there is heavy rainfall which causes the water level of rivers and nearby water bodies to rise above danger level.

3. Alert:

These signals are based upon the urgency and extremity of the situation. If there is some change in water flow of large water bodies such as rivers due to any reason the alert will be sent to engineers to make them aware that it might result in some major situation ahead but if check can be controlled at this point of time.

II. LITERATURE REVIEW

The growth of Internet of Things (IOT) paved the way for significant attention in all fields. The objective and proposed in the Dam Water Level Monitoring and Alerting System using IOT [3] is the application system with integration of Internet of Things to ensure the safety of the public about the prior alerting of flood occurrence due to the increase in the water level in dams/reservoirs. To achieve the objective cloud database technique is maintained which encapsulates the periodic monitoring of water level data and vicinity information. 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 methods of monitoring and alerting systems.

The cradle of paper Water Level Monitoring and Dam Gate Control over IOT [4] is based on the 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 & it is impossible for a man to precisely control the gates without knowledge of exact water level and water inflow rate. We have designed a system in which real time things are interconnected to the web. Water level sensors are placed in the dam to serve the same purpose automatically and forward the status to raspberry pi. Raspberry pi unit checks that input and uploads the status of water level on the web. By this project each and every variation of water level is informed to control rooms through the internet (using blynk application) and nearby people can be informed in time thus saving lots of lives and avoiding the unpleasant scenarios.

According to the Review on IoT Based Dam Parameters Monitoring System [5] When it comes to monitoring the parameters of a dam such as Water Level, Gate Position, Water Discharge and Seepage tank level the manual method fails. This project will help out to automatically measure as well as display the data parameters. The sensors connected to Raspberry pi 3 measures the parameters and shares the data through IoT to Website. The development of this project not only helps dam authority and disaster management to control the parameters as well as common people to know.

There are some places that are more prone to flooding than other places, the implementation in A Real Time Solution to Flood Monitoring System using IoT and Wireless Sensor Networks [6] of flood alert systems near any major water area or body of water provides critical information that can protect property and save lives. Of course, the most effective flood warning methods are very costly and requires high maintenance and also requires highly qualified employee to operate it. Nowadays, there is no idea about when flood will occur so there is need to prewar people who are near the flooded area. Hence, they designed a system to inform the people about the upcoming flood through notification and alert messages. For that purpose, we are going to use some sensors which will helpful to give information about the flood. As well as we are going to give all safe places near the user location where user can migrate. Always we are using map for trace safe location. This system provides actual implementation to organizations, communities and individuals interested in establishing and operating flood monitoring and warning systems.

III. PROPOSED SYSTEM

Based on our Literature Survey and Technical analysis of different techniques, we have proposed a System to automatically control the Dam operations based on Water flow monitoring with help of IoT and ML Model.

Our System will consist of 3 different units:

1. IoT System
2. ML Model
3. Dam Control

1. IoT System:

We will be deploying nodes with Sensors and power supply. These nodes will be deployed near all the water bodies that are somehow connected to the Dam. The number of nodes will be dependent upon the size and volume of water bodies. These nodes will capture the water flow of the water body. It will also contain a threshold value that will be set as danger level for that reservoir. These nodes will be connected to the Central Unit/ Server (Raspberry Pi) through a wired mechanism.

2. ML Model:

We developed a Machine Learning Model that will collect and analyze the data collected from all the nodes. The data collected will be processed and passed through the XGBoost algorithm to train the model so that it will be achieving more accuracy percentage. We will be providing some initial datasets to our system and our model will predict the possibility of flood occurring in the recent times based on water flow patterns.

3. Dam Control:

There is a wireless connection between our central server system and the Dam Control System. Based on the signal received, we will be operating the motors fitted on the doors of the dam. If there are scenarios where flood situations can occur, the gates will be opened slowly and water will be released from the dam in lots so that there won't be an immediate rush situation and we will get time to evacuate the locals.

3.1. BLOCK DIAGRAM OF PROPOSED SYSTEM:

Below is a abstract block diagram for the system proposed:

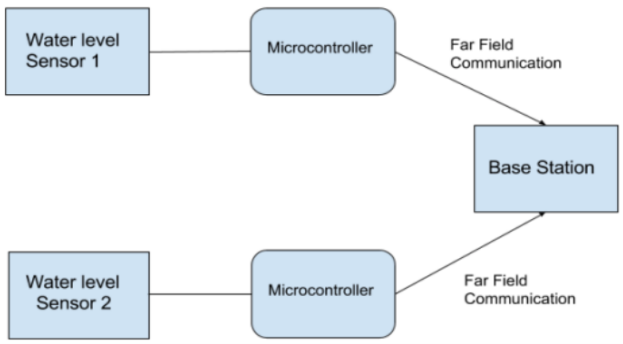


Fig 1.1 Block Diagram of the system

3.2 ALGORITHM

XGBoost is a decision-tree-based ensemble Machine Learning algorithm that uses a gradient boosting framework. In prediction problems involving unstructured data (images, text, etc.) artificial neural networks tend to outperform all other algorithms or frameworks. When it comes to small-to-medium structured/tabular data, decision tree-based algorithms are considered best-in-class right now. This is the reason we selected XG Boost for implementation of our ML Model.

We used Scikit-learn's 'Make_Classification' data package to create a random sample of 1 thousand data points with 20 features (2 informative and 2 redundant). We tested several algorithms such as Logistic Regression, standard Gradient Boosting, and XGBoost. The results using XGBoost were highly optimized and more accurate than others. Hence, we decided to go ahead with XGBoost for final implementation.

3.3 SOFTWARE QUALITY REQUIREMENTS:

3.3.1. Availability:

If the UDP service gets disrupted while sending information to the app, the information must be sent again within the time limit.

3.3.2. Security:

The main security concern is for data security of nodes hence proper login mechanism should be used to avoid hacking. The credentials are provided to the officials so as to avoid unauthorized access of data. Hence, security is provided from unwanted use of recognition software.

3.3.3. Usability:

As the system is easy to handle and navigates in the most expected way with no delays. In that case the system program reacts accordingly and transverses quickly between its states.

3.4. SYSTEM FLOW:

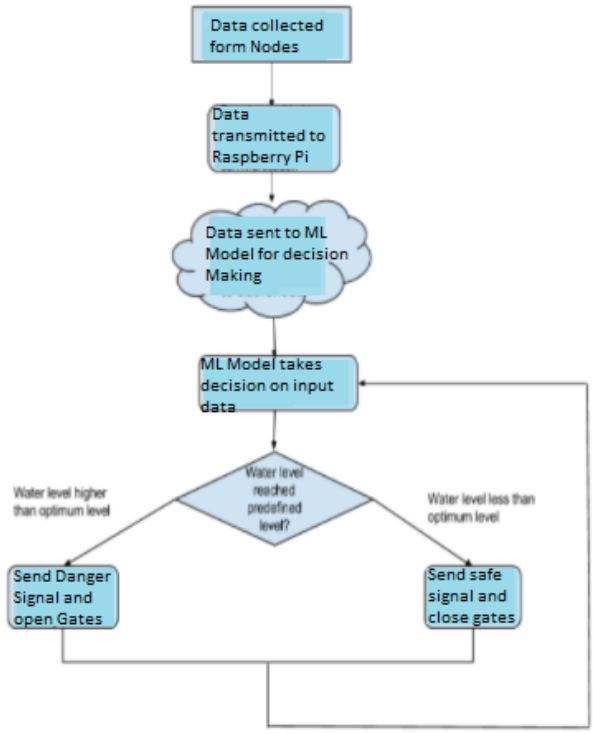


Fig. 1.2. Flowchart for Proposed System

The above diagram represents the complete flow of our system. We start with collecting the Data from the nodes that are installed at different water bodies. This data will be collected and sent to the Base station(Raspberry Pi). The base station then processes the data and makes it suitable for processing purposes. This refined data is given as input to the ML Algorithm and the decision is taken based on the training dataset.

This decision is sent to the dam Gates and they operate according to the signal received. If there is a danger signal then we open the gates of the Dams in particular steps so that it is not a sudden water discharge. In case of a safe signal, no action will be taken but the monitoring will be continued.

IV. REQUIREMENT ANALYSIS

In this section we will be discussing the Hardware and Software requirements for the proposed system.

4.1. HARDWARE REQUIREMENTS:

4.1.1. RASPBERRY PI:

It is a capable little device that enables people of all ages to explore computing, to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

The Pi can run the official Raspbian OS, Ubuntu Mate, Snappy Ubuntu Core, the Kodi-based media centers OSMC and LibreElec, the non-Linux based Risc OS (one for fans of 1990s Acorn computers). It can also run Windows 10 IoT Core, which is very different to the desktop version of Windows.

4.1.2. WATER SENSOR (RAIN DETECTION SENSOR):

Water sensors detect the presence of water and, when placed in locations where water should not be present, placed at danger level they can be used to determine level of water. When Wi-Fi is enabled, the sensor can send out a notification to the homeowner through a smartphone app.

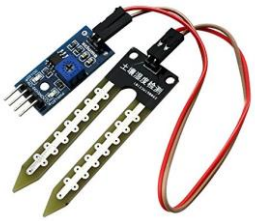
4.1.3. SERVO MOTORS:

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It is used to control the movements of Gates of the Dam.

4.1.4. ULTRASONIC SENSOR:

The Operating voltage is +5V and Theoretical Measuring Distance is 2cm to 450cm. We are using this sensor to get the exact level of Dam. It will help us measure the length of the empty Dam and pass data to the controller.

4.1.5. SOIL MOISTURE SENSOR:



Soil Moisture sensor is used to detect the moisture content of soil which help us analyze the water level rise. Less moisture content will cause a slow rise in water level as most of the water will seep into the ground.

4.2. SOFTWARE REQUIREMENTS:

4.2.1. RASPIAN OS:

Raspberry Pi OS is a Debian-based operating system for Raspberry Pi. Since 2015, it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the Raspberry Pi family of compact single-board computers.

4.2.2. PYTHON:

We are using Python as programming language to develop our code and implement all our models. Python is a General-Purpose Programming Language and hence is suitable for developing ML Model.

4.2.3. SKLEARN LIBRARY:

To implement and train the ML Model we used the sklearn library provided by Python. Sklearn provides a set of functions and classes to train and test XGBoost Model.

4.2.4. PANDAS LIBRARY:

We are using Pandas library for handling the larger amount of data that we will be collecting using our IoT network. All the preprocessing and filtering operations will be performed with Pandas Library.

V. RESULT AND CONCLUSION

We have successfully developed a System with 5 functional nodes collecting and providing all the water related details to a central Raspberry Pi acting as Server unit. The Raspberry Pi then sends the signals to Motors that control the movements of Gates of Dam.

Our ML Model achieved 60% accuracy with continuous training and error resolution techniques. The XG Boost helped us achieve efficiency with optimized implementation.

VI. REFERENCES

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