DESIGN AND DEVELOPMENT OF NOVEL FLOOD DETECTION SYSTEM USING IOT

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ABSTRACT: Devastating floods have emerged as a problem for urban planners and decision-makers in recent years due to an increasing frequency of unprecedented rainfall events all over the world. Flood is a Hazardous phenomenon by which world is encountering from several years. Flooding is a natural calamity that is drawing attention from all around the world due to its detrimental effects on civilization. Because flood events change unlikely, efforts must be done to lessen their impact. Dams are very important, because they are especially used to provide hydroelectricity and for irrigation. As a result, numerous dams have been built in possible locations over the years. Due to the numerous danger considerations connected to the presence of such dams, it has become imperative to create an effective monitoring and management system for the opening of the shutters, hence ensuring a safe water level in dams. Dam management errors can result in man-made calamities. Water levels can alter because of abrupt changes in the levels of nearby lakes or rivers that are connected to it, or because of an abundance of rain in catchment area. Hence in this work, design and implementation of novel flood detection using IoT (Internet of Things) is presented. In this work, GSM module (Global System for Mobile communication) and Thing speak platforms are used to alert the people during floods. This system can effectively detect the flood and loss of lives and property damages can be reduced.

KEYWORDS: Flood detection, DAM, GSM and Thing Speak sensors.

I. INTRODUCTION

The main sources of water supply for metropolitan networks are dams. A large portion of the dams try to meet the various requirements and have their own preferences.

To help the dams, there must be some form of link between the monitoring structures and the administrators' models. In both cases of water scarcity and overflow, Dam Water Management (DAM) plays a crucial role. [1]. The wet season in India starts from June to October. Early rainfall typically occurs in June. Each year, the heavy rain begins in July and lasts through October, with few showers in November. Floods are caused by heavy rain, structural issues, and a variety of human influences. Flooding is influenced by antecedent moisture conditions, terrain, geology, land use, and amount and kind of precipitation [2]. Both the environment and lives can be lost as a result of floods.

A dam is a physical barrier that limits water movement. Dams can be used for a variety of purposes, including storing water, distributing the water evenly among different areas, generating electricity through hydropower, preventing floods, and modifying water flow. The dam's water is utilized for aquaculture, agriculture, industrial purposes, and human consumption. Dams are essential for storing and utilizing water [3].

Firstly the dam was built about 3000 BC. The structure, size, purpose, and material of a dam can be used to classify it. The failure of a dam may be catastrophic. 2000 people died in Gujarat as a result of the greatest dam failure in Indian history. Bad maintenance, earthquakes, heavy rains,

poor design, insufficient capacity, and instability caused due to changes in water level are some of the factors that might lead to a dam failing.

Building dams became essential to modern society's survival as freshwater demands increased and was a major factor in improving the management of water resources in the situation of climate change and water shortages. However, opponents of dams tell that their advantages have been overstated and that socio-environmental factors are being ignored. Second, although being clean and environmentally acceptable energy sources, hydropower projects might not have the potential to resolve the conflicts caused by deterioration, growing populations, climate change, and catastrophic events. Therefore, precise inflow estimation is crucial for reservoir management and operation as well as hydroelectric energy generating and control infrastructure [4].

The goals of disaster management are to minimize potential damage from disasters, ensure immediate and appropriate relief to the victims, and accomplish effective and quick recovery. Natural disasters are characterized by their randomness, the partial availability of resources in the affected areas, as well as dynamic variations in the environment. Due to the unpredictable nature of natural disasters, it is impossible to estimate with sufficient accuracy the particular effects they will have on people and property. The effects of disasters are also significantly harsher when they occur in urban areas due to the higher degree of damage caused to goods and property.

Flooding is the most common and devastating natural disaster, and it significantly affects agriculture, the economy, and human lives, especially in underdeveloped and poorer nations [5]. Usually, flooding cannot be avoided but the destruction causing can be avoided by detecting the flood at the earliest by the system which monitors the water flow continuously [6]. Many poor countries do not have flood checking cells that are properly equipped with sophisticated and adaptable flood disturbance systems. The dam safety committee currently oversees and maintains dam structural health in India.

Pre-monsoon regulatory checks are conducted twice, and most monsoons are performed annually. Members of the committee are from a variety of departments. Checks are made on the spillway, earth bunds, head regulators, gates, and gate motors. The deformations are initially examined visually, and if there is any uncertainty, scanners are utilized along with microscopic testing. The committee presents their findings and suggestions where engineers are attended. This system's drawbacks include the fact that monitoring is not performed on a regular basis, that not all factors are taken into account, and that a larger group of people must be involved. This manual intervention slows down decision-making and can increase the likelihood of inaccuracy.

People who live in flood-prone areas therefore constantly experience the effects of flooding. Keeping a safe distance from floods before they cause severe damage can provide residents of nearby areas enough time to evacuate. The warning and prediction system may be able to lessen the extreme effects of flooding. The creation of a robust communication network (between sensors and controllers) and the creation of a mechatronics system for shutter control are all necessary for the construction of a flood detection system. The system becomes more complex when extreme weather events like droughts and floods are taken into account. Therefore, it is crucial to estimate the inflow to a dam

reservoir accurately in order to minimize losses.

The IoT, Geographical Information Systems (GIS), and remote sensing have all shown to be excellent tools for monitoring and controlling smart infrastructure under heavy load. Due to their dependability, IoT sensors are already widely employed in a variety of applications. IoT sensors were used in the development of numerous smart technologies as well as control devices [7].

Due to its simplicity in terms of size and cost, IoT applications are still in their development in many sectors. Applications built on the IoT don't cost as much to deploy and maintain as human management systems can do. IoT devices are used to collect information, identify risks after disasters, and locate the injured persons [8].

IoT can be regarded as a network of connected devices. It has many sensors, is equipped with programming, and is set up for communication. Electronic devices that enable end users to periodically secure accurate information over the correspondence channel and take into account information exchange among the clients and the various linked devices. The use of IoT and wireless sensor networks for water level monitoring ensures remote observation.

With the use of a Wireless Sensor Network (WSN) and a communication architecture, the IoT paradigm enables quick data transmission to designated control centers. These centers may analyze the data and advise the relevant government, authorities, and citizens to implement effective flood counter measures. Accuracy and responsiveness are ensured by the IoT-based analysis. The IoT has gained popularity and is now a good option for pre-alert systems that monitor the increase in levels in dams. It is essential to develop a real-time dam water level monitoring and early warning system to protect the population and to reduce the risk rate of sudden floods.

Hence in this work, design and implementation of novel flood detection system using IoT is presented. The remainder of the analysis is structured as follows: The literature survey is described in section II. The section III demonstrates presented two levels of sensors for flood detection at dams. The section IV demonstrates the result analysis of presented system. Finally this work is concluded in section V.

II. LITERATURE SURVEY

Sri Rohith P, Catherin R, Bhanu Priya R, Prithvi Krishna K, Dr.Ramesh Kumar P et. al., [9] offers a State-of-the-Art Dam Management System based on IoT in an Indian Environment. This study suggests a cutting-edge reservoir management system that includes sensors that are appropriate for measuring parameters like pressure, water level, inflow velocity, outflow velocity, tilt, vibration, and others. These sensors are all integrated into an Arduino Uno to transmit live stream data to Microsoft Power BI (Business Intelligence), where each parameter is displayed in an appropriate format. The procedure begins with the collection of data from sensors and concludes with the presentation of that data on a dashboard in a control room situated in a distant place that links to a website in which the relevant information can be seen by visitors.

Joni Welman Simatupang and Faiz Naufal et. al., [10] suggests a Flood Early Warning Detection System Based on IoT Network prototype. In this analysis, a rudimentary prototype of an IoT-based flood early warning detecting system is suggested. This essay will also cover who could access the system and how it functions (using an Arduino and an

ultrasonic sensor), as well as where the data must be transferred (to a cloud server) and how the system operates (utilizing an Arduino and an ultrasonic sensor). Whenever the water level reaches a specific height, the system will provide a flood early warning. The findings indicate that the system was functioning properly, but there are still a few limitations, like low sensor sensitivity (approximately 20% accuracy) and low GPRS (General Packet Radio Service) and GSM module reaction to a certain commands that could impact Arduino functionality. This technology will be helpful as one of the options to lower the number of potential flood casualties in the future.

Albert Joshy Varghese, Abin Thomas Jolly, Astile Peter, Bhavana P Rajeev et. al., [11] recommends an IoT-based Disaster Monitoring and Management System for DAM (IDMMSD). A number of dams that are being studied have their water levels being monitored in real-time by this system. Water levels can alter because of significant changes in the levels of nearby lakes or rivers that are connected to it, or because of an abundance of rain in the catchment area. This is an IoT app-based system that will track and provide real-time dam-related information (gate position, water outflow, water level), as well as weather conditions (rain fall, temperature, humidity). The software can be used in either the Autopilot mode or the Manual data mode. They use a variety of sensors in the system to monitor information in real time. For monitoring and control, these are transmitted to the cloud server using the Wi-Fi module ESP8266. All of the water-related issues can be resolved by this solution. Messages are also sent out by the system for public safety. Thus, this system is capable of managing dams and prevents disaster.

K. Vinothini, Dr. S. Jayanthy et. al., [12] presents a Decision Tree Algorithm based IoT based flood detection and notification system. This project attempts to use IOT to monitor flood conditions and deliver alerts when there is a risk of flooding. To identify a flood, rising water levels are measured. To measure temperature, humidity, and water levels at each stage, the system employs three sensors. The PIC (Peripheral Interface Controller) Microcontroller is used to process the obtained sensor values before sending them through Wi-Fi to the IOT. The technology immediately broadcasts sensor values across the cloud. The categorization process is carried out using the decision tree method. This Decision Tree Algorithm offers higher classification accuracy of Minimum Mean Square Error than HyperPipes Algorithm, according to results obtained for Correctly Classified Instances and Minimum Absolute Error.

V. Sathya, Kshitij Arun, Harshitaa Mahajan, Amit Kumar Singh et. al., [13] uses IoT to automate the functioning of Dam. This framework can establish ongoing alarms about the dam's condition and can also signal when certain qualities of the dam have altered from their usual state. A temperature sensor has been used to increase the amount of deterioration in the dams' structural integrity. In essence, the suggested architecture seeks to automate the operation of dams regardless of their various historical situations. This model simplifies the process of managing water levels on a large scale. This method can be used to understand a wide range of water-related concerns. The number of labor needed at each and every dam can be reduced by establishing a headquarters focus.

Herman Yuliandoko, Subono, Vivien Arief Wardhany, Sholeh Hadi Pramono, Ponco Siwindarto et. al., [14] outlines the Design of Flood Warning System Based on IoT and Water Characteristics. IoT is a smart technology that can link to a web service, a smart phone, and sensors to deliver data in real time. This skill can be

intelligently applied to manage and regulate an early warning system. IoT technology is used in this study to monitor and manage the flood disaster early detection system. Sensor data might be transmitted in real time from a sensor to a smartphone utilizing IoT technology. The sensor data includes information about the dam's water properties that will be analyzed in the database. The processing of water characteristic data will determine the level of threat. The users' smartphone applications will receive a notification of that decision. This study will be helpful for in-depth analysis on Indonesia's flood early detection and disaster management systems.

Kavitha. R, Kaviths R, Jayalakshmi, Senthil Kumar et. al., [15] discusses using IoT to monitor and alarm for changes in dam water levels. The water level data and surrounding information are encapsulated in a cloud database technology that is maintained. Periodically, sensor data are gathered and uploaded to a cloud database, in which automatic comparison analytics on the rise of water level are recorded. As a result, the public is automatically made aware of the earlier stages of the water level. Finally, it was discovered that, when compared to the conventional approach of monitoring as well as alerting system, this strategy increases the level of accuracy.

III. NOVEL FLOOD DETECTION SYSTEM

In this section, design and implementation of novel flood detection system using IoT is presented. Floods are unpredictable natural disasters that might occur frequently. Several people died and material losses were happened due to floods. To reduce such kind of losses, design and development novel flood detection system using IoT is implemented. The block diagram of novel flood detection system using Internet of Things is shown in Fig. 1.

This flood detection system contains two level sensors with different threshold levels, a raspberry pi 4, GSM module, Display device, siren, WiFi-module and RS232 cable.

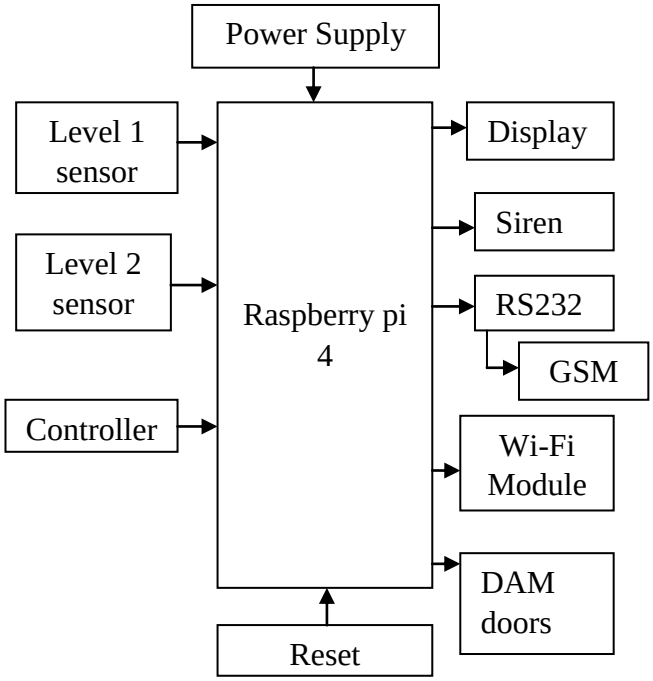

Fig. 1: BLOCK DIAGRAM OF NOVEL FLOOD DETECTION SYSTEM

The spread of IoT platforms in a variety of industries encourages the reduction of human life loss and property losses caused by natural and man-made disasters. The main benefit of the IoT cleared the way for dynamic safety with higher levels of performance accuracy and practicable data analytics.

Two levels of sensors are used in this system. A level sensor is a tool used to maintain, measure, and monitor liquid (and occasionally solid) levels. Water levels can alter because of significant changes in the levels of nearby lakes or rivers that are connected to it, or because of an abundance of rainfall in the catchment area. The sensor converts the sensed data into an electric signal after detecting the liquid level. The framework includes two level sensors, as well as many components connected to a Raspberry Pi 4. The

controller is the component that receives signals from the sensors, analyzes and computes them, and then transmits control signals to a actuators. Controllers are needed to control the whole data and figure out what to do with it. Controller uses that data to make decisions.

An electrical device known as a power supply provides electricity to an electrical load. A power supply's primary function is to transform electrical current from a source into the proper voltage, current, and frequency needed to drive a load. Raspberry Pi requires a power source of 5V. If the supply exceeds the 5v, then its working function can't be guaranteed.

The most recent model of the inexpensive RPi computer is the RPi 4 Model. The Pi isn't like other devices; it's just a credit-card-sized electrical board type, which is found inside a PC or laptop. Single-board computers known as Raspberry Pi (RPi) are now more frequently used to link IoT devices. A computer monitor can be connected to an RPi. It is a competent tiny gadget that permits individuals to investigate computing and learn to write in languages such as Scratch and Python.

In order to predict level, raspberry pi 4 is connected to level 1 and level 2 sensors. Raspberry pi 4 collects the entire database from the surrounding and sends it to the Wi-fi Module which gives the Alerts about Water level and display the water level on display device. The RPi controller processes the sensor information for warning situation.

An interface for serial binary data exchange between two devices is RS-232. It is a common protocol for serial communication that connects a computer to its peripherals so that serial data can be exchanged between the devices. Here it is used to provide communication between raspberry pi and GSM (Global System for Mobile communication) module.

The GSM is a standard Lowe Power Wide Area technology. It is built on eGPRS and intended as an IoT communications cellular system with high capacity, long range, low energy, and low complexity. In general, a customized GSM module is developed to monitor the wireless radiation via SMS (Short Messaging Service). The Raspberry Pi can send serial data to this module, which can then send the data as text SMS to the host server. These modules are made comprised of a GSM module with an RS-232 computer communication interface as well as a power supply circuit.

The idea behind the Internet of Things is to essentially connect any gadget with an on/off switch to a internet. This covers about everything you can imagine, from cell phones to wearable technology. Remote observation is made possible through the deployment of wireless sensor networks and the Internet of Things. Accuracy and responsiveness are ensured by the IoT-based analysis. Flooding caused by the increase of water levels is recognized as a hazardous action that includes the integration of an IoT platform for flood monitoring and pre-alerting. The applications of IoT have certain specific requirements, such as long-range, lower data rate, minimal energy consumption, and cost-effectiveness.

Wi-Fi (Wireless Fidelity) module is a miniature USB (Universal Serial Bus) wireless adapter with massive antenna that supports greater range and speed. An application host processor and a Wi-Fi chip are typically the two major components of the Wi-Fi module. The 802.11 radio physical layer (PHY), baseband, Media Access Control (MAC), and maybe a crypto engine are all components of the Wi-Fi subsystem that enable quick, secure Internet connections.

With the help of ThingSpeak, data can be sent from devices, websites, and sensors to the cloud and saved either in a private or public channel. By default, ThingSpeak keeps data in private channels, however data can also be shared in public channels. ThingSpeak is an IoT analytics platform service that enables the collection, visualization, and cloud-based analysis of real-time data streams. Use online services such as Twitter and Twilio to deliver alerts, send data from user devices to ThingSpeaK, and instantly see live data. Real-time data collecting, data processing, visualizations, apps, and plugins are some of thingSpeak's standout features.

A siren is a tool for creating a lot of noise. The sirens are set in fixed areas and are used to alert people when floods and other natural calamities are present. Ambulances, police cars, and fire engines are among the emergency vehicles that utilize sirens. Utilizing a Liquid Crystal Display (LCD), Cathode Ray Tube (CRT), gas plasma, light-emitting diode, or some image projection technology, a display is an output screen and projecting device that presents text and frequently graphic images to computer users. Resetting typically refers to shutting down and restarting a computer or other device to clear the memory and fix a variety of problems.

Data and the original water level are compared. A basic message alert is sent to the public through GSM if water hits the level 1 threshold, and an LCD display shows the flow rate and time until an overflow occurs. If water level crosses the level 2 sensor threshold value then this system opens 2 to 3 doors of dam and alert is given through the siren and SMS (Short Message Service) is send to the nearby people using GSM module. Thereby floods are detected in real time and effect of disasters will be greatly reduced. With a significant decrease in human deaths and damage to huge properties, this technology protects the safety of the general population. The system also has capabilities like SMS alerts for local residents and SOS (Save Our Chip) for rescue efforts in case of bad weather.

IV. RESULT ANALYSIS

In this section, design and implementation of novel flood detection system using IoT is implemented. The result analysis of presented two levels of sensors for flood detection at dams is demonstrated. In this approach Raspberry Pi controls the whole data and takes proper actions based on the water level. Thing speak which is a IoT platform used to sent the dam condition and water level to social media apps, SMS to alert the nearby people.

If water level at Dam crosses the threshold of level 1 sensor then this system alerts the people through the siren and SMS using GSM module. If the water level at dam crosses the threshold level of level 2 sensors then it open 2-3 doors and alert the nearby people through the siren.

The alert message sent to the nearby people is shown in Fig. 2. The alert message is also sent to the social media apps through thing speaks platform for alerting the people and government and degree of flood detection losses are reduced greatly.

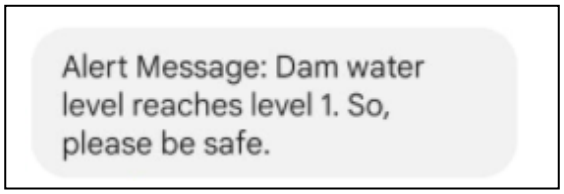

Fig. 2: SMS ALERT

The water levels at different times are monitored to detect the floods and to notify the government about dam conditions. The water levels of dam at different times are illustrated in Fig. 3. The x-axis in Fig. 3 symbolizes time, and the y-axis indicates water volumes in MCM (Million Cubic Meters).

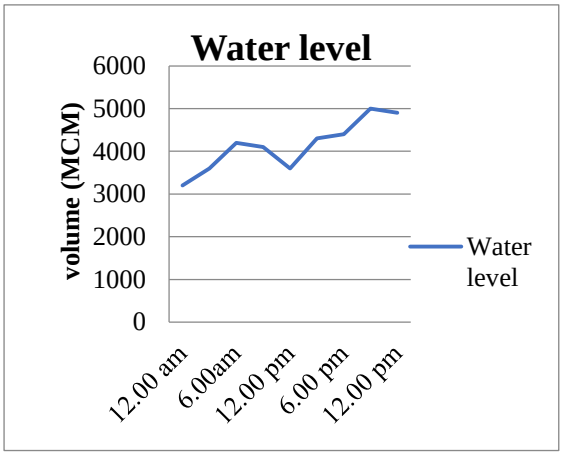

Fig. 3: WATER LEVEL COMPARATIVE GRAPH

This system has greatly minimizes the losses and risks of floods because it alerts the people and it does not open all the door at a time as it opens 2 or 3 doors based on the water level. Thereby, loss of lives will be reduced. The Fig. 4 shows the risk and loss of lives comparison between presented system and manual dam operating systems.

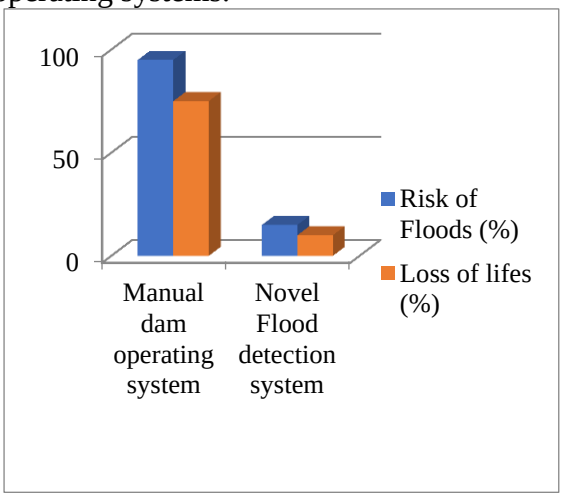

Fig. 4: COMPARATIVE GRAPH FOR RISK AND LOSS OF LIFES DUE TO FLOODS

Moreover presented system does need human presence where as manual dam operating systems require human presence to check the levels of water at the dam. The water level estimation and error rate comparison for manual and presented system is shown in Fig. 5.

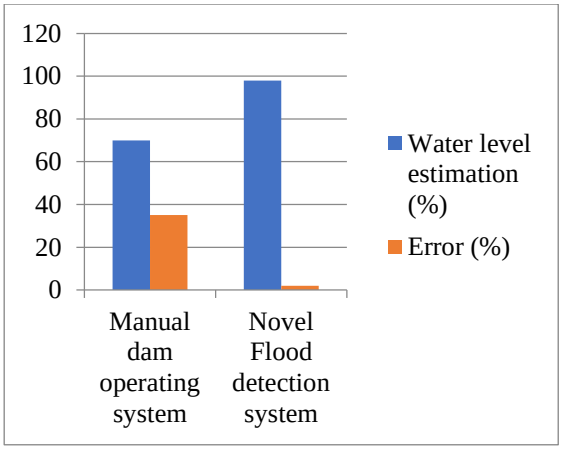

Fig. 5: WATER LEVEL ESTIMATION AND ERROR COMPARATIVE GRAPHS

Compared to manual systems, presented system has effectively estimated the water level and error chance is very less.

V. CONCLUSION

In this work, design and implementation of novel flood detection system using IoT is presented. The expansion of IoT platforms across a variety of industries promotes a decrease in property losses and casualties from both natural and man-made disasters. The main benefits of IoT opened the path for dynamic safety during dam floods with higher level precision in performance and practicable nature data analytics. In this approach thing speak platform is used to alert the people and government about the floods in real time. Raspeberry pi 4 is used to control, monitor and take the actions in real time. The GSM module is used to send the alert message to the nearby people. Compared to manual dam operating systems, novel flood detection system has effectively detects the flood and risk of floods are reduced greatly. In addition at a time, this system only open 2 or 3 doors and it sends a siren about it. Thereby loss of lives and property damage are reduced.

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