A REVIEW ON Flood Prediction and Monitoring System

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ABSTRACT

During floods, the flood monitoring system plays a critical role in assisting the government and community in effectively managing the situation of flood victims and therefore reducing the disaster effect. The proposed system will include a basic monitoring interface, flood data, and short-term water level predictions in the future. Several academics have offered various solutions to the flood problem, such as establishing prediction models and constructing adequate infrastructure. As a result, the primary goal of our research is to develop a real-time flood detection system based on machine learning algorithms and IoT that detects water level and water flow measurements and predicts floods as early as feasible. Although with the help of satellite images we can predict flood conditions, there is a need for a certain system that is more efficient to predict current flood conditions, warn of high flood areas, and provide authority to the government to take required action on the flood situation.

Keywords: *Data Analysis, Sensors, Machine Learning, Mobile Application, Internet of Things, Linear Regression, Android.*

1. Introduction

Among the natural disasters, floods are the most destructive, causing massive damage to human life, infrastructure, agriculture, and the socioeconomic system. Governments, therefore, are under pressure to develop reliable and accurate maps of flood risk areas and further plan for sustainable flood risk management focusing on prevention, protection, and preparedness [1]. Floods are one of the most destructive natural disasters, which are highly complex to model. So there is a need to create systems that might contribute to risk reduction, policy suggestions, minimization of the loss of human life, and reduction of the property damage related to floods.

The intention is to develop a Real-time river-level monitoring and high accurate flood prediction for the

urban Flood Monitoring and Prediction System, flooding caused by Localized Heavy Rain. Due to various riverside environmental limitations, there are limitations in detecting urban river dyke height to alert about flooding [2]. Flood prediction models are of significant importance for hazard assessment and extreme event management. Robust and accurate prediction contributes highly to water resource management strategies, policysuggestions and analysis, and further evacuation modelling [3]. Data Analysis is a process of understanding and evaluating data based on visual interpretations like graphs [4].

IoT is a system of interconnected devices that can collect and transfer data using a wireless network without human intervention. The IoT is the combination of sub-methodologies like wireless sensor networks and it is the mode to connect all the devices by sensors and monitored through the internet [5]. In this era, numerous data-driven procedures are being applied to the massive quantity of data produced to obtain significant benefits. Machine Learning algorithms were used on those data to obtain the results like prediction/ forecasting [6]. This study focuses on predicting the flood earlier using the rainfall dataset and providing alert messages (text messages) to the communities who live near the dams/lakes/rivers. These IoT sensors used here is an ultrasonic sensor which is used to measure the level of the water in the dam in real-time.

The level of water is the most important parameter to predict flood occurrence in natural disasters occurring places. The ultrasonic sensor can be used to detect the water level and, in this case, if the water level reaches above the threshold limit it provides alert messages which also spread through social media. The data fetched from the water level sensor is constantly stored in a cloud server. This measurement of water level is displayed in a dashboard remotely so that people can easily monitor the water level wherever they live. This proposed solution can also be used to monitor the inner quality of water. The alert messages and relevant data regarding the level of water are transmitted to the cloud server and then it will be received by the consumers who are being owned through the user terminal. Thus, the importance of advanced systems for short-term and long-term prediction of floods and other hydrological events is strongly emphasized to alleviate damage [7]. However, the prediction of flood lead time and occurrence location is fundamentally complex due to the dynamic nature of climate conditions. Therefore, today's major flood prediction models are mainly data-specific and involve various simplified assumptions [7].

Thus, to mimic the complex mathematical expressions of physical processes and basin behaviour, such models benefit from specific techniques [8]. The dataset that we have used has features such as water level and water flow of different areas which are in Kolhapur. The dataset we have collected from the University of Kolhapur. After data collection, we have done the data cleaning part and we have taken the data that we required. In our project, we have used the machine learning algorithms such as linear regression/logistic regression, and support vector machine (SVM). The best-fit algorithm is linear regression which give uses 80-90% accuracy. In recent times, India has faced many natural disasters. The floods, cause heavy damage to properties, wild lives, and huge loss of human lives. This problem can be overcome by a proper flood monitoring system integrated with Machine Learning and IoT. The proposed system can be used for better monitoring of water levels in dams. If the flood occurs, it easily communicates the information to the nearby people. The implemented communication systems and transmission technologies are more efficient and can easily adapt to the background technologies.

The proposed methodology has increased efficiency and accuracy for the prediction of floods, and even it gives good efficiency in critical conditions. Overall this proposed system would be advantageous for the people to get enough time to evacuate from the flood-prone areas before the flood occurs [9].

2. Literature Survey

Vishwanath P Baligar et.al [10] This paper describes the survey on flood issues and a proper way to detection of floods and alerting systems. They have used Neural networks for rainfall forecasting and it performs efficiently and also used advanced technologies like machine learning which provides the practical application of scientific knowledge for a purpose that is very important in monitoring different kinds of behaviours of a machine. IoT is also one of the prime roles that provide an alert when a flood occurs. They have also explained different machine learning (ML) algorithms namely Support vector machine (SVM), Linear regression, Logistic regressions, etc. The prediction of rainfall and flood every year is visualized in a graph and table.

Pooja Mane et. al [2] specify that before and after the flood destroyed the people should get ready and feel safe. They have applied an Android application, an SMS notification system, and a Website to display the condition of flood for easy access. For the Machine learning prediction part, they have collected the data from government sites. Matplotlib and so on libraries are applied for data visualization, the best-fit algorithm is Support vector

machine (SVM) and logistic regression of 79%. The website includes information like current year rainfall, past average rainfall, and increased rainfall average. In the end, the website will show an alert if a flood occurred.

Surya Prakash P R et. al [11] illustrated building a good water level monitoring system on dams for the ease of people present in that specific area. IoT plays an important role which includes sensors like an ultrasonic sensor that calculates average rainfall in a particular area and water level, a Pressure sensor, and a Humidity sensor – DHT11 which helps to identify the
humidity and the climatic changes this will give us the output in digital format. Real-time data is collected from the sensors and machine learning algorithms like SVM are used to predict and provide us the output in the graphical format. This data is stored on the firebase platform and this database is connected to the respective web/mobile app.

Kruti Kunverji and Krupa Shah et. al [12] have developed a project which tells us about flood prediction using different machine learning methods. They have taken the Bihar and Orissa region for study, from Bihar they have collected data from 10 different areas, and the same for Orissa also on monthly bases. Dataset contains columns like location, year, month, minimum-maximum temperature, cloud cover, rainfall, etc. Now from the original dataset, they have given 75% of it to train the model. They have used Random Forest, Decision Tree, and Gradient Boost and the best-fit algorithm is Decision Tree with 94.4% accuracy. Whereas Gradient Boost Algorithm provides an accuracy of 87.9% and Random Forest Algorithm provides an accuracy of 92.4%.With the help of Android, the Application government will give the alert to respective areas as early as possible. People in that area where the flood is addressed will get an alert too.

Md. Asraful Islam et.al [13] This research involved the design & implementation of a water monitoring system that provides a solution to remotely monitoring water levels, early warning of events, and sending notifications when critical water levels are reached through mobile and accessing all information via a website. The Hardware system includes critical level sensors, Warning level sensors, Sensor input Heder Xbee, Normal level sensor, Battery, 3.3-volt regulator, LED, and Battery charger. This IoT module will calculate the water level. Bangladesh data have been collected. They have used different types of technologies such as Java, PHP, MySQL, Apache, Netbeans, HTML, Javascript & CSS. The Web Module will provide information regarding real-time water levels in Bangladesh. Water Development Board which is having Historical data for Bangladesh and also an alert system through Mobile SMS. They have included the Map of Bangladesh which will show the details of the current water level by adding the labels, locations, and descriptions on the map. The green colour on the map will indicate the situation is normal and the red colour indicates the critical water level condition. We think it will open a great opportunity for disaster management in Bangladesh .

Paul Munoz et. al [14] This paper focus on various kind of efficient Machine Learning(ML) technique. It includes three river states *No-alert*, *Pre-alert*, and *Alert* for flooding. The area selected for flood prediction was the Tomebamba catchment located in the Tropical Andean Cordillera of Ecuador, South America (UTM coordinates).Multi-layer perceptron (MLP) models achieve the highest performance followed by LR, with *f*1-macro (*log-loss*) scores of 0.82 (0.09) and 0.46 (0.20) for the 1 h and 12 h cases. It shows the results of the discharge and precipitation lag analyses for the flood forecasting model 1-h before the flood would occur. They have developed this applications to boost the awareness of society of floods.

3. Methodology

3.1. Component

A methodology is a structured overview of the research. It gives you a brief understanding of how to identify, select, process, and analyse the sequence of work flow. This project's broad framework will be divided into phases, depending on whether hardware or software development is required. The following fig describes the architecture of the flood monitoring and prediction system(FMPS).

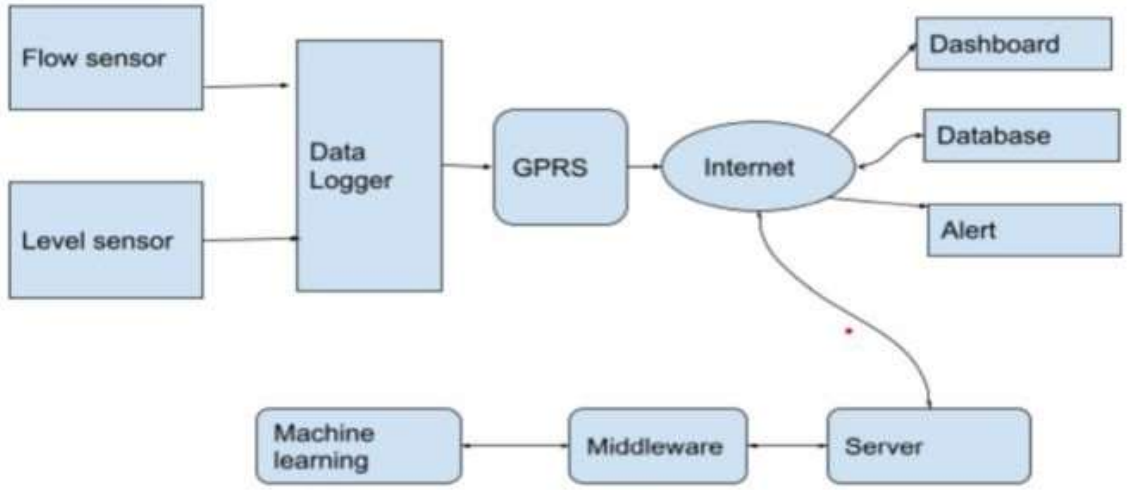


Fig. 1 Architecture of FMPS

A) Hardware:

A number of hardware components were employed to implement the FMPS. An accurate flow measurement is a critical step from both a qualitative and economic standpoint.

IoT Module

Flow sensor :

The water flow sensors that are used are electronic devices that are designed to detect the presence of water for purposes such as providing an alert in time to allow the prevention of water damage [15]. The system comprises the YF-S201, a well-known water flow sensor. It is also used to monitor water level on different rivers.

Level sensor :

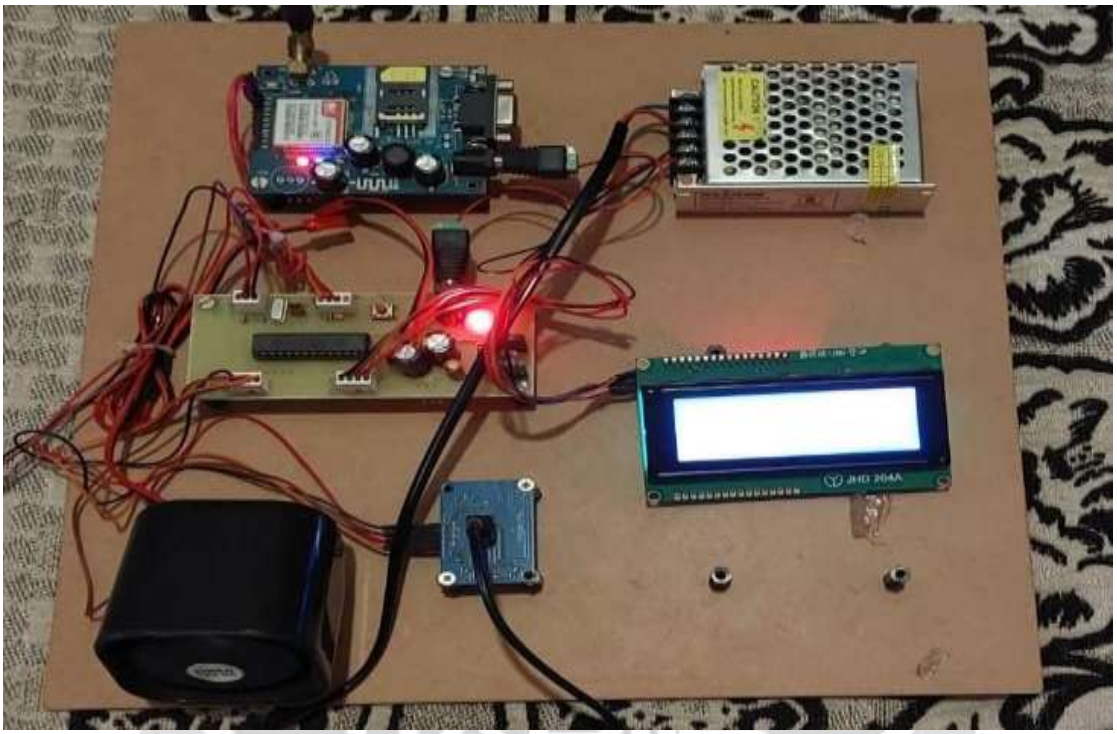
An ultrasonic sensor is used to detect the level and if the water level reaches the parameter, the signal will be freed in real-time to the social network.

Data Loggers:

Data loggers are electronic devices that automatically monitor and record environmental parameters over time. It contains a server to receive the information and a computer chip to store it. It will pass the value to GPRS.

GPRS:

The system collects and transmits timely hydrological data using GPRS (General Packet Radio Service) via a mobile phone network from remote hydrological stations to the data centre in the case of the Lower Mekong River Basin (LMRB).



IoT Circuit

B) Software

Internet :

Flooding is a way to distribute routing protocol updates quickly to every node in a large network.

Server :

The server handles the communication between the admin and user.

Middleware :

A middleware which enables application servers to communicate with the Machine Learning Model.

Machine Learning :

Model will get the real-time data from sensors via all the middle systems and predict whether the Flood will occur or not.

Dashboard :

FMPS contains the Webpages where all the data will be displayed on respective pages.

Alert :

In this Section, the Alert Message will be sent to each higher authority of that region.

3.2. System Model

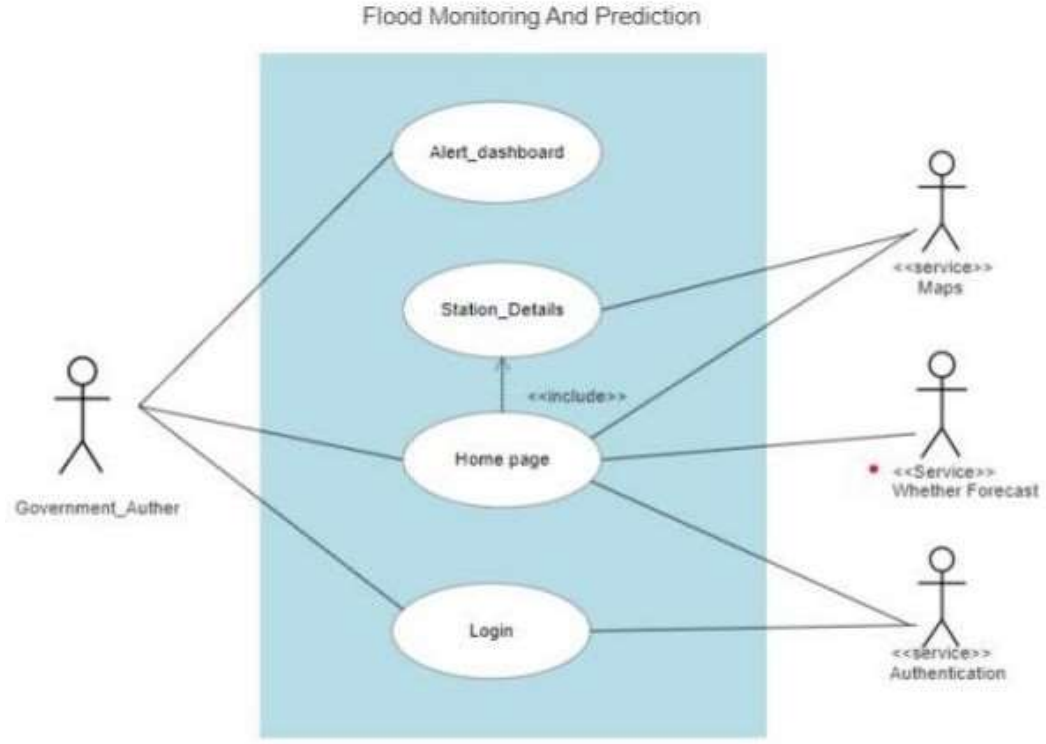


Fig. 2 Use Case Diagram of FMPS

Primary Actor: Government Author.

Precondition: Govt. Author Login to System.

- State of the Art of ML Methods in Flood Prediction:

To predict the flood model , the previous year's data of flood events in addition to real-time cumulative data of a number of rain gauges or other sensing devices for various return periods, are required. The major ML algorithms applied to flood prediction and detection include ANNs, neurofuzzy, adaptive neuro-fuzzy inference systems (ANFIS), support vector machines (SVM), wavelet neural networks (WNN), and multilayer perceptron (MLP) [7]. The system uses linear regression to predict hydrological model. In the following fig, a flow for building ML model is shown as below:

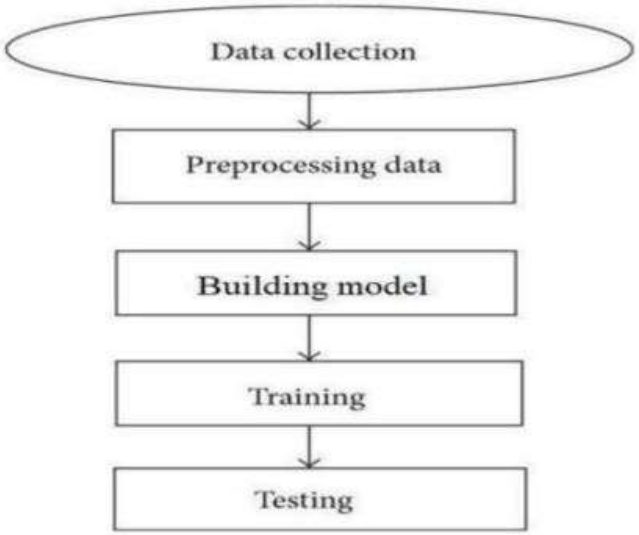


Fig. 3 Basic Flow for building ML model [7]

3.4. DataSet :

The dataset consists of previous years' flood record in the districts of Kolhapur, India. The features of our dataset include areas from the Kolhapur district such as Nitawade, Balinge, Shingnapur, Rajaram Bandhara, and Ichalkaranji with their water flow and water level parameters. The data collected is from the years 2011–2020. The data points were collected from the irrigation department of Kolhapur. The dataset had to be downloaded in a district-wise manner in CSV format. The dataset collected has been gathered on a monthly basis.

Nitawade-meter	Nitawade-cusecs	Balinge-meter	Balinge-cusecs	Shingnapur-meter	Shingnapur-cusecs	RB-Meter	RB-visarg-cusecs	Ichalkaranji-meter	Ichalkaranji-cusecs
547.72932	65282	546.48	66016	545.6	66100	544.59	66164	548.5	64558
546.74127	64302	545.26	65031	545.2	65037	544.18	65067	547	63196
545.55898	63286	544.04	64190	545.2	64199	543.85	64205	548	62659
547.09083	63417	545.57	64060	544.9	64150	543.85	64201	547	62643
546.76356	63271	545.26	64023	544.8	64057	534.8	64068	547	62253
546.97278	63068	545.57	63867	545	63952	543.78	64001	550	62432
546.45228	63162	544.65	63723	544.7	63802	543.72	63868	548.75	62345
546.55394	62786	544.96	63743	544.9	63751	543.7	63802	547.166667	61912
545.72575	63123	544.5	63662	544.6	63727	543.7	63802	547.5	62189
547.21739	62395	545.26	63197	544.1	63268	543.5	63269	547.833333	61696
546.59688	62168	544.96	63163	544.9	63226	543.5	63269	546.5	61456
546.30952	62405	544.65	62976	544.3	63070	543.45	63136	546	61560
545.60301	62204	544.35	62958	544.8	62984	543.42	63070	548.5	61505
546.12531	61791	544.35	62685	544	62735	543.29	62737	548.25	60908
546.54557	61414	544.65	62310	544.3	62320	543.19	62398	548.25	60759
545.24829	61630	543.89	62231	543.9	62274	543.17	62313	546.5	60768
546.11341	60939	544.65	61759	544.2	61806	543.04	61888	548.333333	60269
545.08034	61189	543.74	61704	544.3	61705	542.99	61718	546.75	60052
545.61376	60477	544.35	61292	543.2	61347	542.89	61379	548.25	59482
546.34321	60608	544.5	61123	543.8	61144	542.84	61209	547.5	59702
545.40435	60071	544.04	61064	543.9	61114	542.84	61209	550	59480
545.65936	60172	544.04	60882	543.5	60955	542.78	61040	548	59426
545.57207	59922	544.35	60843	543.9	60928	542.76	60955	549	59040
545.9159	60150	544.5	60694	543.7	60789	542.73	60870	549	58982
55.263356	60024	53.95	60803	544	60853	542.73	60870	548	58926
545.29232	59812	544.04	60748	544.2	60788	542.73	60870	547	59203

Snapshot of Dataset

4. RESULTS AND DISCUSSION

The following figures shows the dashboard of flood monitoring system. We have taken three terms in consideration i.e. Heavy, moderate and light rainfall. It displays the current weather conditions. In the main dashboard, there four subpages consist of home, Alert Dashboard, IOT Data Visualization and Inputs.

Fig. 4 Weather Forecast Dashboard

The Fig 5 shows two stations in which you have to add input of water level and water flow respective to the stations. When we click on Submit button, it will redirect to the Alert Dashboard.

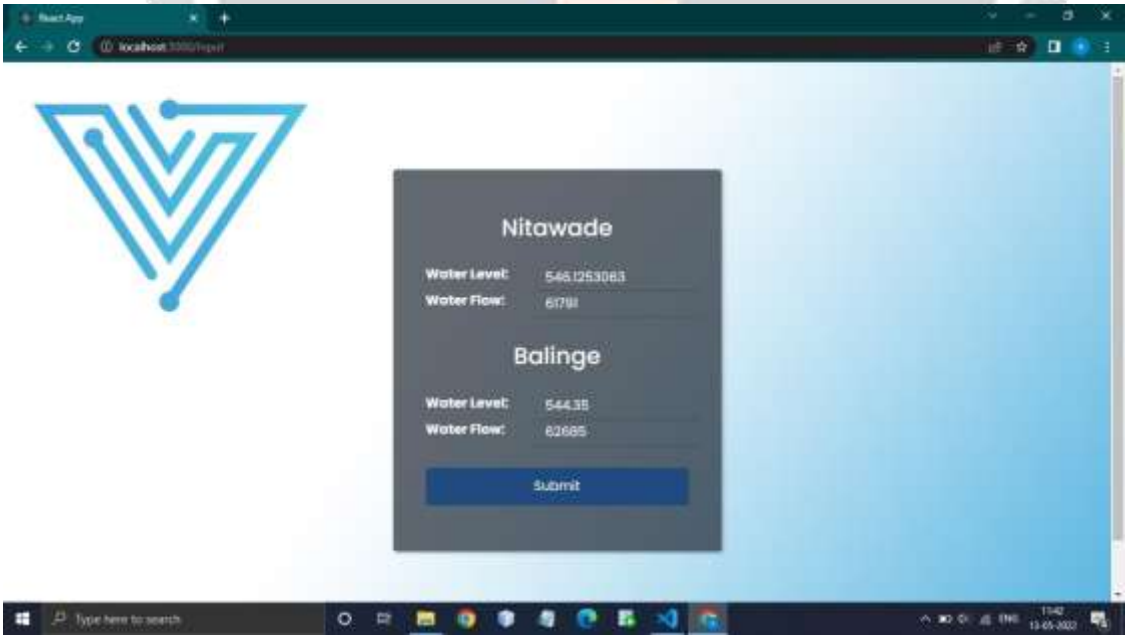


Fig. 5 Input

The following Fig. 6 predicts the output of remaining stations in the sense of water level, water flow that includes in Kolhapur District.

Fig. 6 Alert Dashboard

In Fig 7, data visualization is done of different stations present in Kolhapur. It shows the water-level and water-flow of a station in chart format. By using visual elements like charts data visualization tools provide an accessible way to see and understand trends, outliers, and patterns in data.

Fig. 7 IOT Data Visualization

5. CONCLUSION

The study is all about detecting the level of the flood and generating a real-time flood Monitoring system using IoT and Machine Learning for effective flood management of the "Panchganga" basin. The proposed methodology has increased efficiency and accuracy for the prediction of floods, and even it gives good efficiency in critical conditions. The flood monitoring System using Arduino detect the water flow and water level and predict the flood occurrence and show an alert on a website and mobile phones. The system also helps the government save money and time in rescue operations and helps them start the relocation operations before the flood hits the town.

The flood monitoring system detects if it continues to rain heavily, the government may check the flood condition on their laptop or mobile phone from anywhere as it will give a required alert before a flood condition occurs. At the same time, this intelligent system can remotely manage the alert signal and the gate, allowing excess water to flow. The method could be improved by sending SMS as a warning signal to those who have not subscribed to mobile data or do not have access to the internet. Flood prediction and monitoring systems can be extremely beneficial to everyone in society. The flood model uses linear regression with 80- 90% of accuracy.

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