International Journal of Aquatic Science
ISSN: 2008-8019
Vol 12, Issue 03, 2021

Data analysis for flood monitoring using Machine Learning and Internet of Things

Ramya R[1],Sathish Kumar G[2], Venkata Uday L[3], Surya Prakaash P R[4], Shakthi Rahul K S[5]

[1,2]Assistant Professor, Department of Computer Science and Engineering, Bannari Amman Institute of Technology, Erode, Tamil Nadu, India
[3,4,5]UG Scholar,Department of Computer Science and Engineering, Bannari Amman Institute of Technology, Erode, Tamil Nadu, India

Abstract: Flood is one of the most common natural disasters that are causing damages to life and the country's economy. This study focuses on Flood monitoring using Data Analysis &Internet of Things (IoT). This design incorporates certain important elements like Water level flowing in the dam, humidity, and the water flow based on the rainfall rate. These parameters are closely monitored for predicting and releasing water from the dam at a moderate rate in advance to avoid flood issues faced by the public who are living near the dams. The sensor aggregates and collects the data from various sources that are controlled by the Wireless Sensor Network (WSN) from the controller. The sensor information can be analyzed and the system creates an alert to the public community through the siren and alert message using a smart communication device. The design of the automated system is to be optimized for the control of the shutter position. The failure of the opening and closing of gates has resulted in water scarcity and its wastage. Manual gate results in human errors. Hence this system is controlled by the machine learning mechanism to follow the servo motors and the electronic control to monitor the flow of water according to the water level at the given time. Thereafter, the data stored in the cloud is further used for the prediction. The system can be implemented through mobile/web applications.

Key words: Data Analysis, Sensors, Machine Learning, Mobile Application, Internet of Things.

1. INTRODUCTION

Data Analysis is a process of understanding and evaluating data based on visual interpretations like graphs [1].IoT is a system of interconnected devices which are able to 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 internet [2].
In this era, numerous data-driven procedures are being applied to massive quantity of data produced in order to obtain significant benefits. Machine Learning algorithms were used on those data to obtain the results like prediction/ forecasting[3].
India is peninsular country, with tremendous climatic form. The rainfall may vary on the different parts of the country. Many parts of the country will have a heavy rainfall and results in flood. Due to flood, the water bodies will reach its maximum limit within the short period of time. It causes serious danger to the wild lives and human beings if the water bodies were not monitored and maintained properly [4][5].

In this article an efficient solution for opening theshutters of the dam when the water reaches the threshold limit has been emphasized with the help of modern technology - IoT using sensors. To develop this efficient solution, we have to perform three steps: Data collection for analysis, data processing, collection of hardware and software tools required for the project & spreading the alert message called flood warning to the people. These automated flood warning systems are usually inexpensive and they are always easy to implement. The primary factor for implementing these kinds of projects is cost and fortunately these automated flood warning systems are inexpensive so they can be implemented at a large scale and it can save lots of lives.

Rainfall datasetin India, sub-division wise monthly data for 115 years from 1901-2015, which is taken from the Kaggle.According to the dataset, every year at least two states are severely damaged due to floods. So to overcome this, flood monitoring system will be useful for the people affected due to floods.

This study focuses on predicting the flood earlier using the rainfall dataset and providing alert messages (via websites/mobile application & iOS applications/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 the flood occurrence in natural disaster occurring places. The ultrasonic sensor can be used to detect the water level and, in the case, that 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 the 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.

In this article, Section 2 contains the literature review, the proposed system is discussed in the section 3, Results and discussions were given the section 4 and section 5 contains the conclusion part.

2. LITERATURE REVIEW

The android and IoT platforms were integrated to sense the water level in the water bodies. The sensor will send the information to the firebase cloud once the water level reaches the threshold limit. The people can inspect and access the data through mobile platform [6].

If there is a constant heavy rain in the particular area, then the people who living in that area can continuously monitor the water level in the nearby water bodies through hand held devices with internet connection. The smart system will open the gate of water bodies to let out the extreme water current [7]. This system will not be useful if there is not internet connectivity and hand held devices.

Thingspeak platform along with the HTTP protocol on local area network is used to store and retrieve the data from the systems areenabled to predict the flood in the flood prone areas. It alerts the nearby people by giving the alert sound once the water level reaches the maximum limit [8].

Flood monitoring and alert system are developed by using the open weather API. Water level in the water bodies will be calculated by taking the time between the transmitting and receiving sound waves using the ultrasonic sensors. Various sensors were used to find the temperature, humidity and speed of water. These technologies were integrated into the android platform to predict the water disasters at the early stage [9].

In the existing flood monitoring system, the flood is monitored in local real-time and the alert is sent to the nearby communities living near the dams/lakes/rivers. The authors have considered the parameter of rainfall but they have limited the distance to certain meters as they have connected the warning system to the devices with short ranges.

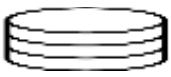
In our proposed flood monitoring system, we have taken all the rainfall parameters and the data is sent via WIFIto the medium of cloud. Thus the alert message will reach the nearby communities with the very minimum time period and alert siren will be produced once the water level reaches the maximum threshold limit in the water bodies. Even the local communities can monitor the water level through their handheld devices.

3. PROPOSED METHODOLOGY

Inthis article, we have used the Rainfall dataset in India from the Kagglefor predicting the rainfall at different parts of the country at a particular time based upon the seasons. Granularity is on monthly basis and this data is taken from 36- metrological sub-divisions located in India, where the amount of rainfall is being measured in Millimeters(mm).Using Machine Learning(ML) models we have predicted the future rainfall of India in different places.

IOT SENSORCLOUD STORAGEPYTHON CODE

GRAPHICAL OUTPUT



FIREBASE STORAGE

MOBILE APPLICATION

Fig.1 Workflow of theflood monitoring system

3.1 Machine Learning Algorithms

In our project, we have used the machine learning algorithms such as linear regression/logistic regression, support vector machine (SVM), matplotlib for plotting the graphs.

3.1.1. Linear/Logistic Regression

Linear regression is used to determine or identify the relationships between two columns/variables in a dataset. Logistic regression is used for analyzing a dataset that has one independent variable or more. The results obtained from analyzing the variables is either 0s or 1s/true or false.

3.1.2. Support Vector Machine (SVM)

The support vector machine is used for classification between any set of groups present in the dataset. The objective of the SVM is to draw the best fit line which isused to differentiate between two different classes or groups present in the dataset.

3.1.3. Matplotlib

Matplotlib is the libraries which can be used for creating visualization by plotting graphs where we can differentiate the rainfall rate based on states when the rain occurs & further differentiates the quantity of the rainfall of each city at each month.

3.2 Hardware Modules

The required hardware modules are the sensors, microcontroller and the materialsforpower supply. The objective of these hardware components isto control and measurethe pressureof water. It collects the data on water level and the information is stored in the cloudthrough the communication of WIFIand the data is being enabled to pass the information through the internet.

3.2.1 Microcontroller

The microcontroller helps in processing the information which is being fetched from the sensors and this information is being sent to the admin through the medium of the cloud.

3.2.2 Sensors

The sensors which help to give the information to the microcontroller from various nodes located at a differentplace[10]. The sensors that are required for this project are as follows:

The ultrasonic sensor-This sensor is used to measure the level of the water and the average rainfall that is being occurred at a particular place[11]. Ifwater level strikes at a particular level it emits very high frequency so these echo signals are reflected in the sensors and it gives an alert message to the microcontroller and send the information to the cloud. The ultrasonic sensor consists of 4-pin. The 4-pins are used to measure water level, trigger, ground connection & the last current.

Pressure sensor - BMP Barometric sensor is used to identify the atmospheric pressure present inside the water.

Humidity sensor - DHT11 sensorworks on the principle of one wire protocol which identifies the climatic changes and the humidity which gives us the output in a digital format.

3.2.3 Power Supply

High energy of power supply is not needed, so the current we get in the AC power supply is being converted to the DC power supply and it can be used in the implementation.

3.3 Database Module

The values that are being fetched by the microcontrollers from the sensors are sent to the cloud via WIFI. The cloud will have the access ofall the registered users. This stored data is being redirecting to the websiteswhere the userscan access the information about the condition of flood occurring.

4. RESULTS AND DISCUSSION

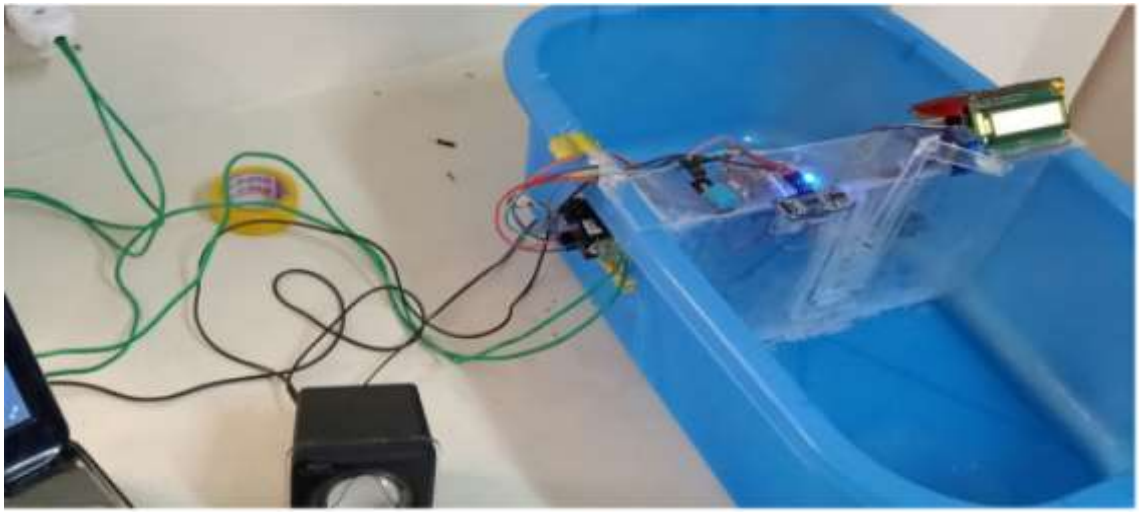


Fig.2Simple prototype of the flood monitoring System

Fig 2. Consist of Node Mcu, Digital output for displaying the humidity, speaker for the siren, ultrasonic sensor. The threshold limit set is 7mm so whenever it reaches the limit the gates will open and siren occurs.

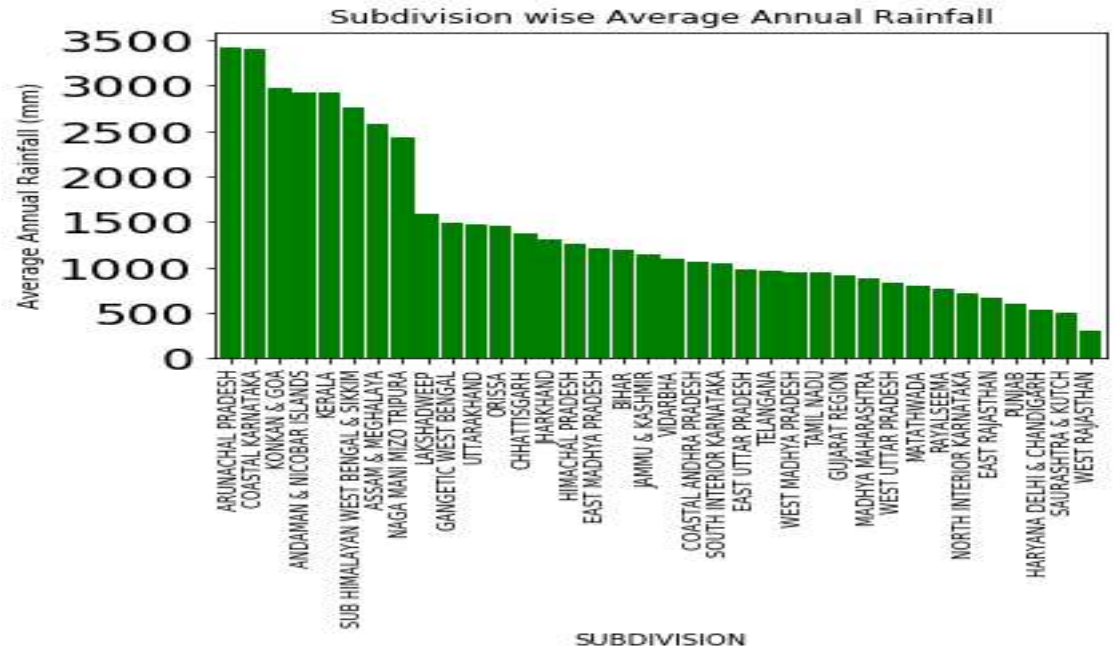


Fig.3 Subdivision wise rainfall

The algorithm used here is bar plot using Matplotlib library to the subdivision wise average rainfall vs. subdivision wise states. The above graph defines the maximum amount of rainfall that occurs always in Andaman Nicobar Islands, Assam, and Meghalaya, Arunachal Pradesh, Bihar, Chhattisgarh. The minimum amount of rainfall occurs in Uttar Pradesh, Rajasthan, Madhya Pradesh, and Uttarakhand.

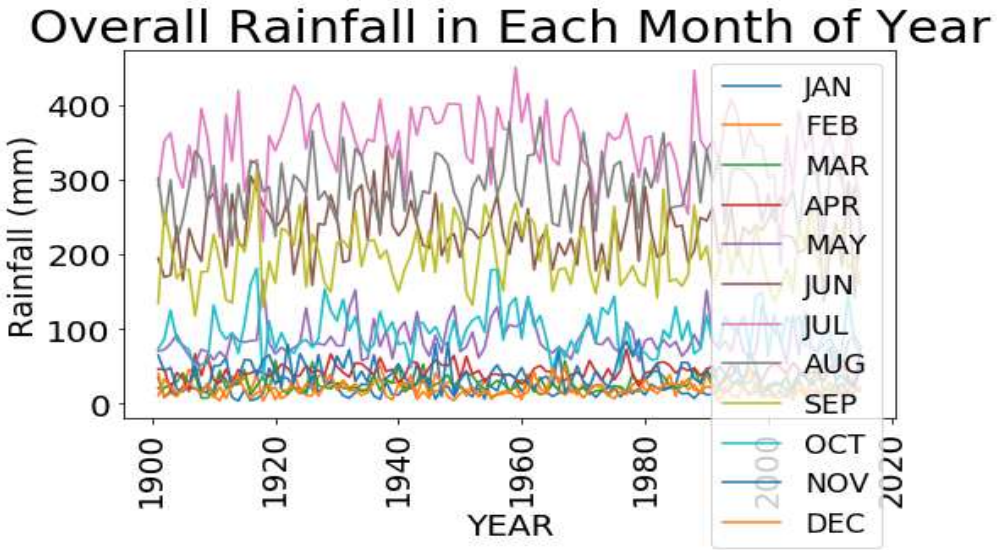


Fig.4 Rainfall in each month of each year

Scatter plot is being used to find the rainfall in each month of each year, using the matplot library it is found that the amount of Rainfall was increased every year in July.

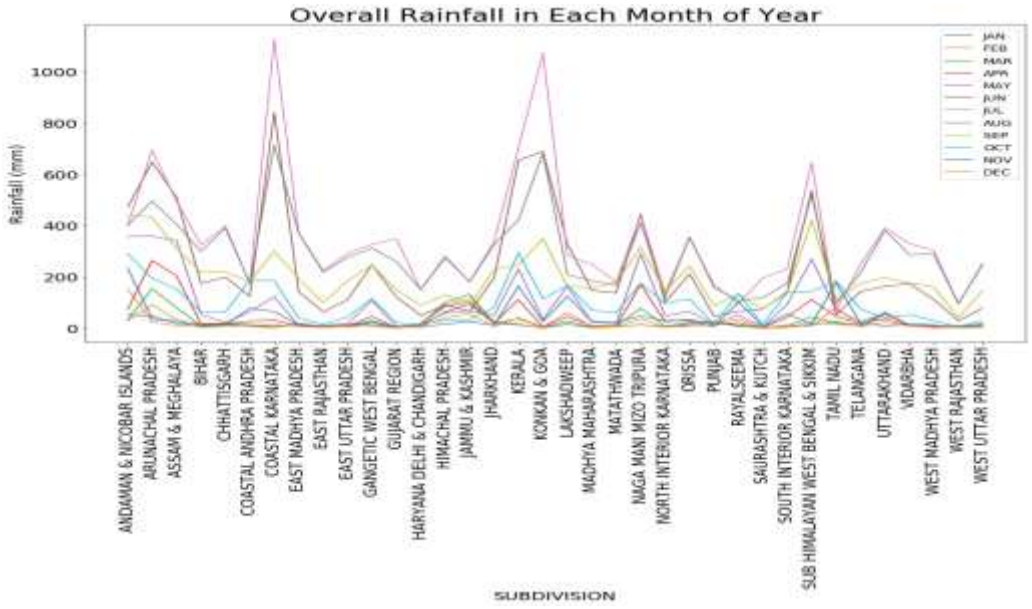


Fig.5 Overall rainfall in each month of the year vs. states

By analyzing the Rainfall data the amount of rainfall in each state with respective months was plotted. In every state of India the maximum amount of rainfall occurred in the month of July. More amount of Rainfall was in Arunachal Pradesh, Karnataka, Madhya Pradesh, and less amount of rainfall in the states of Bihar, Punjab, and Odisha.

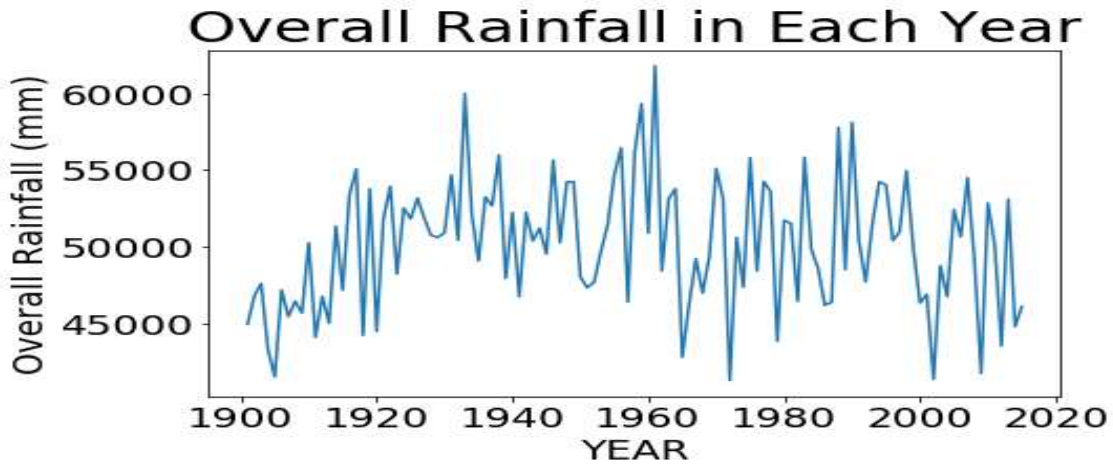


Fig.6 Range rainfall in each year

Using pyplot library we can easily analyze that the rate of rainfall was increasedin the year of 1961. Rainfall rate wsas increasing rapidly compared to last few years from theseData Analysis reports. The average amount of rainfall was in the range of 50000 to 55000, the graph represents the overall rainfall analysis each year.

In the existing system the authors have used the parameters based on the drainage system which may lead to some errors and some have connected to the Bluetooth so the message passing to the people becomes difficult. In this article the parameters are taken using the rainfall and predict the accurate rainfall at a place of the country and sending the alert information through the website dashboard stating the gates are being opened.

5. CONCLUSION

In recent times, India has faced many natural disasters. Due to the floods, it causes heavy damages toproperties, wild life's 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, andeven it gives good efficiency at 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.

6. REFERENCES

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