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Literature Survey on Flood Prediction and Alerting using IoT and Machine Learning

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Abstract : The importance of knowing environmental conditions is undoubtedly these days.Knowledge of having environmental conditions will help us to know better about our surroundings. Due to global warming it has become harder to determine the type of weather around us. Thus frequent monitoring and prediction of the weather is difficult. Thus we need proper information about the weather. Thus the decision maker can take the appropriate decision of the weather. So the decision maker needs to develop a system that can monitor and predict the weather in real time conditions. The Internet of Things(IoT) is very helpful for predicting and monitoring this kind of situation. As it can work with real time data as well as the past data that was recorded earlier. This IoT sends data through Wireless Sensor Network(WSN) to the computational devices so that the result can be generated. Thus many have moved from physical parameter flood prediction to real time computational monitoring. The proposed system uses different atmospheric sensors such as humidity , temperature , pressure and rainfall. The recorded data is stored and passed to the device and thus the result is obtained.

I. INTRODUCTION

The surroundings around us are termed as environment. All living and nonliving lives according to nature. As we are surrounded by other elements of nature such as land , water , air , atmosphere and also living elements such as plants and animals. Thus it is important to interact with all the elements. The environment also includes different other factors such as pollutants which makes it difficult for the human to live in. Thus when the ratio of the pollutants become higher it becomes harder for the human to determine the type of weather. Thus environmental monitoring is important as it helps us to monitor the weather conditions. This can be done using various sensors which will collect all the data from the environment such as temperature, pressure, humidity, rainfall and will transfer it to the device which will help us to know the weather accordingly.

As the temperature of the earth is increasing gradually , there is an increase of global warming all over the earth. Due to which the weather and climate of the earth is not predictable. Thus we need a model which can predict climate change and can monitor the climate also.

For this reason, we need to create flood level sensing devices which will detect the water level. This system is integrated to the microcontroller board which will help to send the data each time the water reaches the threshold value .Ultrasonic sensor is used to detect the water level. The Raspberry pi module will help to connect the internet and keep track of data on a daily basis. The data through the Raspberry pi module will be stored in a cloud. If water level reaches threshold value, people will get alert messages on their phone through android applications. And LED and Buzzer can be used to alert people. This will be done through prediction algorithms. Machine learning can be used for prediction. This system can also predict the possibility of flooding before flooding takes place.

Every year in the month of June to September the weather of India is rainy. As it rains every year this month in our country. Thus there is a probability that when the river basins get flooded by water the flooded water may rise and can cover the whole city. The change in climate has caused global warming and due to which there is an increase in natural disasters such as floods, volcanic eruptions , earthquakes etc.. In our country India the flood prone areas covers almost 12.5% of the country. The states that are considered as flood prone states are West Bengal , Orissa , Goa , Kerala , Gujarat, Uttar Pradesh, Andhra Pradesh and Maharashtra.

Humans have tried to predict and to stop the damage caused by the natural calamity but we are not able to do that so. Thus it becomes harder for human beings to overcome the damage caused by the flood or any other natural disaster. Thus we need a model or a prototype that can predict the flood that might occur.

The IoT device used in the model is Raspberry Pi , many authors have used this device because this device is a small single board computer that works in Linux. This device helps the user to use machine learning and thus the large amount of data can be worked

accordingly. The figure of the Raspberry Pi is shown below. The model has many other sensors attached to it which can manually be removed and these sensors are used to monitor environmental parameters such as rainfall, humidity, pressure, temperature and water level.

Figure 1: Raspberry Pi 4 Model B

II. LITERATURE SURVEY

In 2017, author Swapnil Bande and Dr. Virendra V. Shete [bande, n.d., 1] has created a model using environmental parameters such as humidity, temperature, pressure and rainfall were used by an array of sensors and then the data created is compared using ANN techniques. Further, different machine learning techniques are compared and then the best results are obtained. The advantage in this model is that the author has used the Levenberg-Marquardt algorithm which uses momentum learning and gives 88% accurate results.

An android application [kartika, n.d., 2] have been made by author Ni Komang Ega Kartika, Muhammad Ary Murti and Casi Setianingsih in 2019. The application predicts output for next three months using Radial Basis Function Neural Network and Antares. Antares uses a RESTful approach for developing API. the output that are obtained by using datasets that are further carried out by three steps, they are testing, training and prediction.

In 2017, an alert application of flood was developed by author Jayashree S, Sarika S, Solai A L,Soma Prathibha [prathibhha, .d., 3]. They have used ZigBee technology and the application also works when the network is not present. This means that this application is network independent. The user can make an emergency call or might send the SMS to their family members. The alert application consists of user registration, display of dam water levels and safe zone mapping. Which means that the user can regularly get updates of the water level and can move to a safer place where the flood may not arise.

In 2019, author Arjun N, Prof. Nikhil Binoy C, Keerthi C, Sreerag S and Ashwin H Nair [nair, n.d., 4] have searched about the water levels at two different places that are Dam and Canal. This means that the prediction of flood will be at two levels: Dam prediction and Canal prediction. Here in this model Multilayer Perceptron is used as a Neural Network. And as an activation function Backpropagation and Tan-Sigmoid function for the network. The accuracy of this model is 78%.

Title : Flood Alert system with Android Application
Author : Mohamad Nazrin Napiah, Ismail Ahmedy, Mohd Yamani Idna Idris, Md Asri Ngadi [ahmmedy, n.d., 10].Advantages :This system gives a warning to the user in real time regarding the flood disaster and also gives other information.When there is danger, it gives notification to the user with an alarm on the mobile phone.It provides location to the user.It reduces the cost of the whole system.Zigbee protocol has free communication frequency and uses low power consumption and saves hardware cost. Disadvantages :System has some limitations because the devices are built for peer-to-peer connectivity and not built in the context of a mesh network.

The device is not suitable to be implemented in a large network.

Title : Real-time WSN Based Early Flood Detection and Control Monitoring System.
Author : Tibin Mathew Thekkil, Dr.N.Prabakaran [prabakaran, n.d., 11] . Advantages :Remote monitoring can identify any environmental threats before it occurs.The mobile clients can examine the data, sight the condition of the monitoring area by browsing, mails & short message service.This system is economic, user friendly programming.It uses low power.Disadvantages : Climatic changes. Network connectivity.

A. Flood Detection

The detection of flood is important as when the water level rises at the river basin the life of people living near that area faces difficulty. Thus the author has used different types of sensor near the dam and near the river basin so that when the increase in water level is noticed then the system may give an alert to the people living nearby places. The author Swapnil Bande[2] has introduced a model that detects the flood using several different parameters such as water level, humidity and other environmental sensors. The block diagram of the model is shown below.

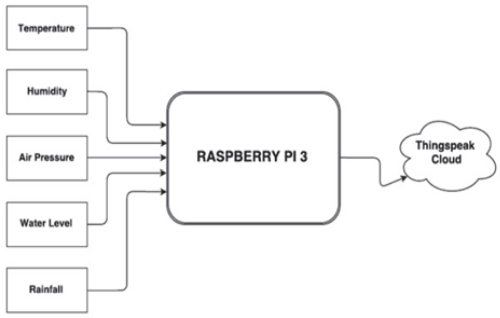

Figure : 2 Block Diagram of Single IoT node.

Each IoT device is connected with different environmental sensors and thus this device is connected to WiFi using WLAN(Wireless LAN) technology.

B. Flood Alerting

The alerting of the flood has been done by WSN(Wireless Sensor Network) which is cheaper and affordable and does not have much high maintenance. This model uses simple calculations and uses multiple variable robust linear regression methods which are easy to understand. The sensor collects all the data from the environment and thus stores this data on the cloud server. The cloud server used in the paper[2] is ThingSpeak. The data gets updated on the server as the IoT node collects the data. The data collected from the server is sent to the MATLAB and thus different machine learning techniques are performed.

The ANN(Artificial Neural Network) is used for prediction analysis. As this technique works upon non-linear time series data obtained from the sensors. The block diagram of the ANN with three layers. They are an input,hidden and output layer.

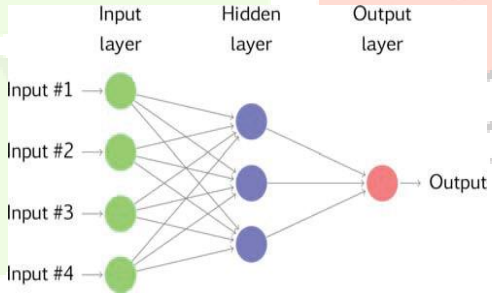

Figure: 3 Basic ANN architecture

The other technique used by author Swapnil Bande[2] is NARX(Nonlinear Autoregressive network with EXogenous inputs) for prediction of flood. It is a dynamic recurrent network with feed-forward connections having multiple layers of network. The block diagram of the NARX architecture is shown below.

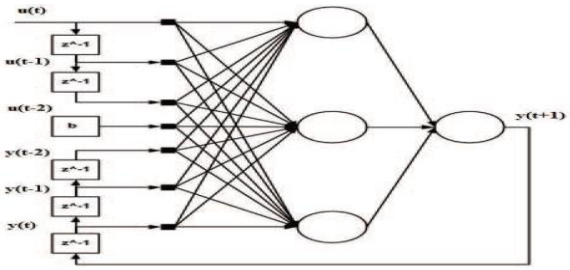

Figure: 4 NARX Architecture

C. Early Flood Warning

This system is developed to warn the people when floods arrive. In this model ZigBee is used and also a model is developed which can also be used when the network is not available. The user can make emergency calls and also can send messages. The Gradient descent with adaptive learning algorithm and the Levenberg-Marquardt algorithms are selected as training algorithms for evaluating the

performance. The explanation of both algorithms are given below. Here the author[2] has compared both algorithms and the result is obtained.

The Gradient descent with adaptive learning algorithm.Fig. 5 depicts the regression toward the mean of the real movement (dotted line), the predicted values (black points) and the mean of the predicted values (blue line). For an ideal prediction case, the blue line should copy the dotted line and the parameter value would have to be one. The result of the regression is 0.6838 which equals approximately 68% similarity between the target and the predicted output.

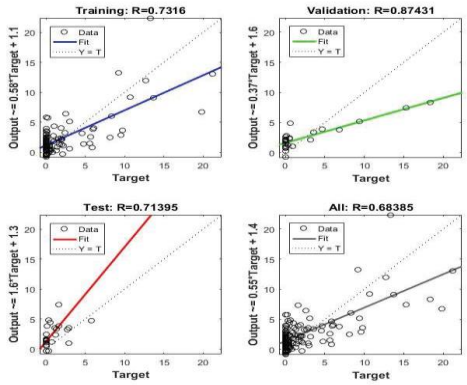

Figure : 5 Regression Plot of Gradient descent

The Levenberg-Marquardt algorithm uses momentum learning instead of the learning rate. Fig.6 depicts the regression performance for this algorithm.

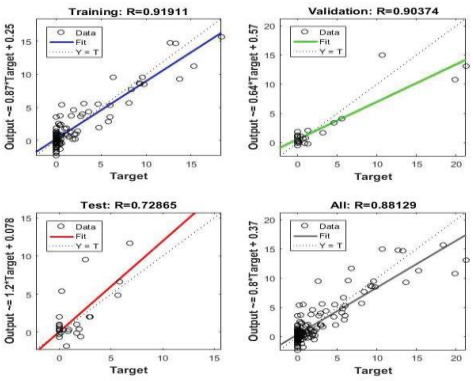

Figure : 6 Regression Plot of Levenberg-Marquardt

III. CONCLUSION

As we have seen that it has been easier to read and understand the real time data and work on it. Thus, working with Wireless Sensor Network that is based on an environmental monitoring system has become easier as this system is cheaper and does not need high maintenance. As these papers consist of the survey of all different papers where the description of enviornmental weather conditions and also the flood prediction is available. Thus, in the future the people will be highly reliable on the environment sensors based model which will help IoT and other real time based technologies to make decisions and will help the people to predict the flood and other natural disasters. The results of both the algorithms are compared by the author[2]. The results are shown below.

Best Performance Parameter	Gradient Descent With Adaptive Learning	Levenberg-Marquardt
Result	0.68	0.88
Train MSE	8.8671	2.3106
Validation MSE	9.9483	7.2713

Test MSE	10.6759	4.8720
Epochs	32	6

Figure : 7 Comparison of Results of two algorithms

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