A NOVEL RAIN FALL PREDICTION SYSTEM USING MACHINE LEARNING TECHNIQUES

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ABSTRACT: In India, Agriculture is the key point for survival. For agriculture, rainfall is most importantRainfall prediction is one of the challenging tasks in weather forecasting. Accurate and timely rainfall prediction can be very helpful to take effective security measures in advance regarding: ongoing construction projects, transportation activities, agricultural tasks, flight operations and flood situation, etc. Rainfall prediction is a fundamental process in providing inputs for climate impact studies and hydrological process assessments. However, Rainfall event is a complicated phenomenon and continues to be a challenge in forecasting. Research on rainfall prediction contributes to different fields that have a huge impact on our daily life. Predicting the rainfall is very important in several aspects of one's country and can help from preventing serious natural disasters. With the advancement of computer technology, machine learning has been extensively used in the area of rainfall prediction. Hence in this work, A novel Rain fall prediction system using Machine Learning techniques is presented. The ML techniques like feed-forward neural network, Back Propagation Network algorithm (BPN), Nonlinear Autoregressive Network with exogenous inputs (NARX) and Adaptive Neuro Fizzy Inference System are used to predict the rain fall in real time.

KEYWORDS: Rain fall, Prediction, Machine Learning, Adaptive Neuro Fizzy Inference System (ANFIS).

I. INTRODUCTION

In India, Agriculture is the key point for survival. For agriculture, rainfall is most important. Rainfall is a key geophysical parameter that is essential for many applications in water resource management, especially in the agriculture sector. Predicting rainfall can help managers in various sectors to make decisions regarding a range of important activities such as crop planting, traffic control, the operation of sewer systems, and managing disasters like droughts and floods [2]. Rainfall is a key part of hydrological cycle and alteration of its pattern directly affect the water resources. The changing pattern of rainfall in consequence of climate change is now concerning issues to water resource managers and hydrologists. Rainfall projection is utmost necessary all over world and it plays a key role in human life. It's cumbersome responsibility of meteorological department to analyze the frequency of rainfall with precariousness. It is difficult to forecast the rainfall precisely with varying atmospheric condition. It is conjectured to predict the rainfall for both summer and rainy seasons. This is the primary reason because of this there is necessity to analyze about the algorithms adaptable for rainfall prediction [1].

Understanding future behaviors of precipitation is important to make plans and adaptation strategies, but the climate system is very complex and normally required sophisticated mathematical models to simulate. Additionally, modeling the variability of rainfall events becomes more challenging when local-scale projections are required. Now a days, the innovations in technology mainly focus on controlling and monitoring of different devices over wirelessly over the internet such that the internet acts as a medium for communication between all the devices. Most of this technology is focused on efficient monitoring and controlling of

different. Rainfall prediction is crucial for increasing agricultural productivity which in turn secures food and quality water supply for citizens of one's country. The scarcity of rainfall has a negative influence on the aquatic ecosystem, quality water supply, and agricultural productivity. Agriculture and water quality depend on the rainfall and water amount on a daily and annual basis. Therefore, accurate prediction of daily rainfall is a challenging task to manage the rainfall water for agriculture and water supply. Accurate rainfall prediction has become very complicated in recent times due to climate change and variability [3].

Predicting the amount of daily rainfall improves agricultural productivity and secures food and water supply to keep citizens healthy. Prediction of rainfall gives awareness to people and know in advance about rainfall to take certain precautions to protect their crop from rainfall. Many techniques came into existence to predict rainfall. Machine Learning algorithms are mostly useful in predicting rainfall [6].

Various researchers conducted studies to improve the prediction of daily, monthly and annual rainfall amounts using different countries' meteorology data. Researchers applied data mining techniques, Big Data analysis, and different machine learning algorithms to improve the accuracy of daily, monthly and annual rainfall prediction. According to the results of the studies, the prediction process is now shifted from data mining techniques to machine learning techniques [5].

Advances in computational technologies and the rapid development of advanced machine learning algorithms have amended the understanding and management of many geo-environmental problems. The main advantage of machine learning over traditional techniques is its capability to handle high-dimensional and complex non-linear datasets [7].

Many classification algorithms such as Random Forest (RF), Decision Tree (DT), K-Nearest Neighbour (KNN) and others have been investigated for the prediction of rainfall [4].The performance among these algorithms widely varies, leaving room for enhancement by varying training and testing ratios or combining different techniques. However, rainfall prediction continues to be a challenging task. Therefore, selecting suitable methods in classifying rainfall over a region is vital. Meanwhile, machine learning algorithms have been described to enhance rainfall prediction accuracy.

Hence, in this work, a novel rain fall prediction system using machine learning techniques is presented. The section II describes the literature survey. The section III presents a novel rain fall prediction system using Machine Learning Techniques. The section IV presents the result analysis of presented approach. The conclusion is provided in section V.

II. LITERATURE SURVEY

Gaurav Verma, Pranjul Mittal, Shaista Farheen et. al., [8] describes Real Time Weather Prediction System Using IOT and Machine Learning. The system utilizes a temperature and humidity sensor i.e. DHT11 and a light intensity sensor i.e. LDR. The sensed data from the sensors are uploaded to a ThingSpeak cloud server using NodeMCU and ESP8266-01 module. The data is also displayed on a customized HTML webpage for monitoring the real time values. A logistic regression model is used for setting up the machine learning environment. This model is trained using the pre- recorded values of sensor data. Further, NodeMCU records the data from sensors i.e. temperature, humidity and light intensity and then the values are transferred to the Jupyter

notebook that utilizes a python environment.

Onkar Amale, Rupali Patil et. al., [9] presents IOT Based Rainfall Monitoring System Using WSN Enabled Architecture. This analysis makes specialty of a flexible and efficient WSN (Wireless Sensor Network) for detecting rainfall-induced landslides. WSN which offer the high quality rainfall monitoring at very cheap rate in terms of labor invested and capital. This paper includes the WSN-enabled architecture for rainfall monitoring system to transmit and collect real time data using GPRS (General Pocket Radio Service) via a cellular network. The data is sent from remote stations to the web server known as Weather Underground. Contribution work is an approach is bandwidth compressed waveform signal for increasing the number of connected devices Performance analysis using SVM machine learning classifier for prediction of rainfall.

Meng-Hua Yen, Ding-Wei Liu, Yi-Chia Hsin, Chu-En Lin & Chii-Chang Chen et. al., [10] describes Application of the deep learning for the prediction of rainfall in Southern Taiwan. Echo state network (ESN) and Deep Echo state network (DeepESN) algorithms are used to analyze the meteorological hourly data from 2002 to 2014 at the Tainan Observatory in the southern Taiwan. The results show that the correlation coefficient by using the DeepESN was better than that by using the ESN and commercial neuronal network algorithms (Back-propagation network (BPN) and support vector regression (SVR), MATLAB, and the accuracy of predicted rainfall by using the DeepESN can be significantly improved.

M. S. Bennet Praba, Antony John Martin, Siddharth Srivastava, Ajay Rana et. al., [11] describes Weather Monitoring System and Rainfall Prediction Using SVM Algorithm. The system proposed is an advanced solution for weather monitoring that uses IoT to make its real time data easily accessible over a very wide range. This system deals with monitoring weather and climate changes like temperature, humidity, wind speed, moisture, light intensity, UV radiation and even carbon monoxide levels in the air using multiple sensors. These sensors then sends the data to the cloud as cloud is used as a storage platform. The data uploaded to the web page can easily be accessible from anywhere in the world. The data stored in the cloud is then classified using Support Vector Machine algorithm to predict whether it is going to rain or not. The data is then represented graphically and displayed for the user. Due to the compact design and fewer moving parts this design requires less maintenance.

III. A NOVEL RAIN FALL PREDICTION SYSTEM

In this section, a novel rain fall prediction system using machine learning techniques is presented. The block diagram of presented approach is shown in fig.1.

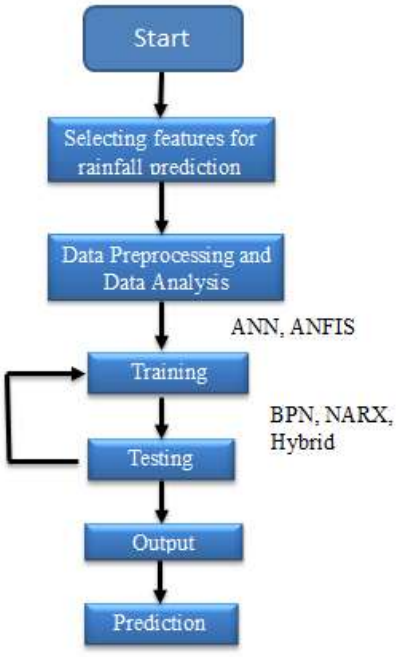

Fig. 1: Architecture for Rainfall prediction using Machine learning Techniques

The dataset (i.e. Ranfall in India) from kaggle is used in this system. This dataset contains monthly rainfall detail of 36 metrological sub-divisions of India. The data refers to details on climatological normals of district wise rainfall (in mm) calculated with the data for the period 1901-2015.

Having irrelevant features in data can decrease the accuracy of the models and make the model learn based on irrelevant features. Feature selection helps to reduce over fitting, improves accuracy and reduces training time. Feature selection is one of the important phase, where we only select those features which contributes to the rainfall prediction model thus helps in reducing training time and increases accuracy of the model.

Data pre-processing is a data mining technique that converts raw and inconsistent data into useful understandable format for the model. Raw data is inconsistent and incomplete and contains missing features along with many errors. As per data exploration and analysis we have learned that raw data for our model contains many null values which must be replaced with their mean value. We can also handle the missing values either by deleting irrelevant column or row. Encoding of categorical data is done as model is based on mathematical equations and calculations hence it is necessary to convert these categorical data into numeric. Feature scaling is the final stage in pre-processing in independent variables is brought into specific range so that no any variable dominates the other variable.

After preprocessing the dataset data is divided as training and testing data. the training and testing test is applied to ML models for rainfall prediction. In this system, the ML techniques like feed-forward neural network, Back Propagation Network algorithm (BPN), Nonlinear Autoregressive Network with exogenous inputs (NARX) and Adaptive Neuro Fizzy Inference System are used to predict the rain fall.

The feed-forward neural network has multilayers for the processing of elements. Each layer processes the input data that it receives and forward the results obtained to the next layer. For this processing, each layer operates independently to generate the resulting that is forwarded to the next layer. The result obtained through processing of each layer is ultimately obtained from the output layer. Between input and output layer; there are hidden layers. The elements that process the input data work like the neuron's in the human brain, these are called artificial neuron's . The neuron's in the layers send messages or information to other neuron's through a channel called connections.

Back propagation Algorithm: The feed forward back propagation is used to detect the error and consequently highlight the performance of the network using the certain inputs, number of neuron's and to check the validity and accuracy of the output obtained. In the back-propagation model by the ANN(Artificial neural network); weights are decrypted and adjusted in the neural network. The system performs several cycles of back propagation with the input data to get the desired output. The back propagation a very simple yet efficient algorithm, it consists of (n) number of processing elements with functions of input and output.

The Nonlinear Autoregressive Network with exogenous inputs (NARX) is a recurrent dynamic network, with feedback connections enclosing several layers of the network. The NARX model is based on the linear ARX model, which is commonly used in time-series modeling.

Adaptive Neuro Fizzy Inference System: The ANFIS(Adaptive neuro Fuzzy

inference system) is an efficient machine learning and artificial intelligence network that is sometimes advantaged over the neural networks. The ANFIS aims at reducing the complexity of the operation and simplify it to get the desired results and output. It also uses the neuron's for processing the data, the neuron's work as nodes. The neuro-fuzzy system introduces a set of rules for each operation that also stores the data and information for the future operations. The rules introduced depend on the inputs and outputs. It has a domain knowledge which is commonly practised for obtaining the outputs. The concepts of adaptive networking are used with certain techniques to process the desired output. The output depends on the updating parameters and their collection. The node is the processing unit of the neuro-fuzzy.

This system predicts the rain fall weather rain will fall or not. If rain falls it predicts the perception of rain. The performance of ML algorithms is compared to know the better technique.

IV. REUSLT ANALYSIS

In this section, a novel rain fall prediction system using machine learning techniques is implemented using python. The result analysis of presented approach is evaluated here. The Fig. 2 shows the training the dataset (Rainfall vs Temperature).

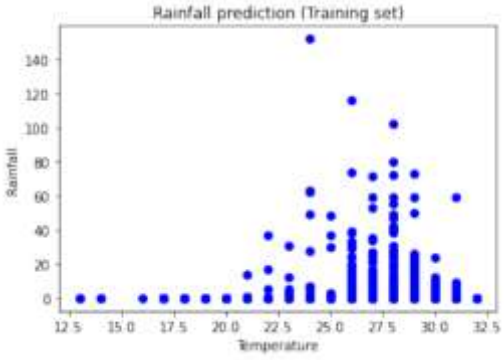

Fig. 2: Training Set (Rainfall vs Temperature)

When temperature is 23-27 the Occurrence of Rainfall is Likely High. The Fig. 3 shows the training the dataset (Rainfall vs Humidity).

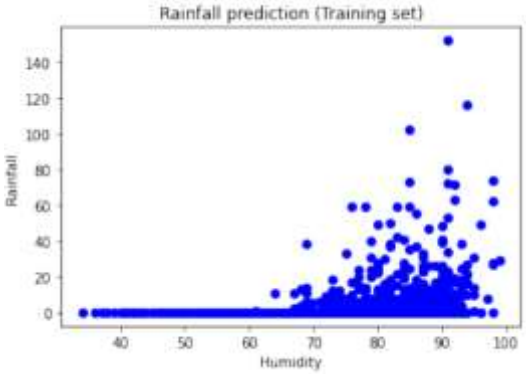

Fig. 3: Training Set (Rainfall vs Humidity)

When the humidity is 70-95 The Rainfall is likely High. The Fig. 4 shows the training the dataset (Rainfall vs Visibility).

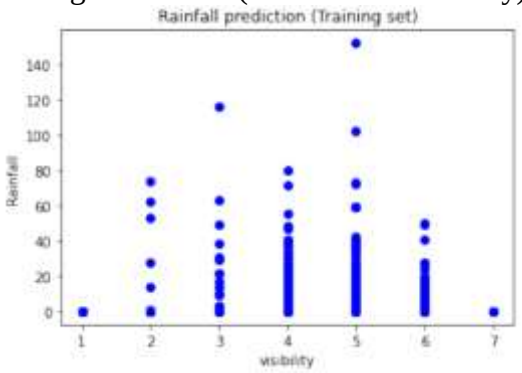

Fig. 4: Training Set (Rainfall vs Visibility)

When the Visibility on Radar is 3-6, The Rainfall is High. The Fig. 5 shows the Compiling of obtain results based on previously recorded Rainfalls.

Fig. 5: Compiling of obtain results based on previously recorded Rainfalls

The Fig. 6 shows the Results afters Compiling obtained.

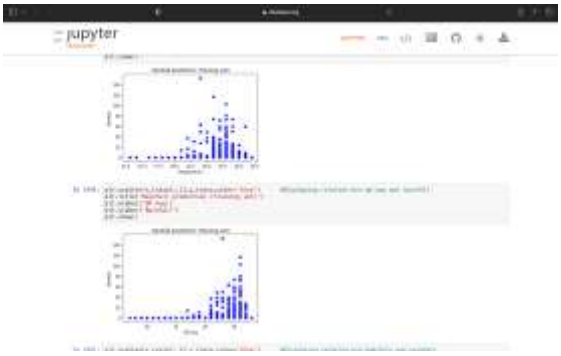

Fig. 6: Results after Compiling

The Fig. 7 shows the Output formed by taking all Training sets Data into Single Graphic Output.

Fig. 7: Output formed by taking all Training sets Data into Single Graphic Output

Hence, this system has significantly predicted the rainfall.

V. CONCLUSION

In this work, a novel rain fall prediction system using machine learning techniques is presented. This work aimed at building a predicting system using ML techniques that could predict monthly rainfall accurately and efficiently with minimum error. This system incorporated different areas and used their rainfall data with different neural networks like ANFIS and ANN, BPN and MARX through training the networks with these inputs and outputs. The trained data is tested and then validated by making a comparison between actual and predicted data. The system used feature extraction to deduce the output prediction that could be more precise and accurate. The neural networks with different algorithms and functions were trained with rainfall parameters and the previous rainfall data to predict the results in this study. After training and testing; the results were compared to check the efficiency of the system; the RMSE's were recorded to make sure that the system will operate not only to make the prediction but also the accurate data will be obtained. This work employed back propagation, NARX and Hybrid algorithms to forecast the rainfall. This system predicted the rain fall very accurately and effectively.

VI. ACKNOWLEDGEMENT

We thank CMR Technical Campus for supporting this paper titled "A NOVEL RAIN FALL PREDICTION SYSTEM USING MACHINE LEARNING TECHNIQUES", which provided good facilities and support to accomplish our work. Sincerely thank our Chairman, Director, Deans, Head Of the Department, Department Of Computer Science and Engineering, Guide and Teaching and Non- Teaching faculty members for giving valuable suggestions and guidance in every aspect of our work.

VII. REFERENCES

[1] Vikas Kumar, Vishal Kumar Yadav, Er. Sandeep Dubey, "Rainfall Prediction using Machine Learning", International Journal for Research in Applied Science & Engineering Technology (IJRASET**),** Volume 10 Issue V May 2022, ISSN: 2321-9653

[2] B.Meena Preethi, R.Gowtham, S.Aishvarya, S.Karthick, D.G.Sabareesh, " Rainfall Prediction using Machine Learning and Deep Learning Algorithms", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878 (Online), Volume-10 Issue-4, November, 2021

[3] Nana Kofi Ahoi Appiah-Badu, Yaw Marfo Missah, Leonard K. Amekudzi, Najim Ussiph, Twum Frimpong, Emmanuel Ahene, "Rainfall Prediction Using Machine Learning Algorithms for the Various Ecological

Zones of Ghana", IEEE Access (Volume: 10), 2021, DOI: 10.1109/ACCESS.2021.3139312
[4] Lakshmitha.M, Anisha.G, S.Rajesh, B. Venkatesan, "Rainfall Prediction Using Deep Learning Technique", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 08 Issue: 10, Oct 2021
[5] Chalachew Muluken Liyew and Haileyesus Amsaya Melese, "Machine learning techniques to predict daily rainfall amount", Journal of Big Data (2021) 8:153, doi:10.1186/s40537-021-00545-4
[6] Cmak Zeelan Basha, Nagulla Bhavana, Ponduru Bhavya, Sowmya V, "Rainfall Prediction using Machine Learning & Deep Learning Techniques", 2020 International Conference on Electronics and Sustainable Communication Systems (ICESC), DOI: 10.1109/ICESC48915.2020.9155896
[7] Ananta Man Singh Pradhan and Yun-Tae Kim, "Rainfall-Induced Shallow Landslide Susceptibility Mapping at Two Adjacent Catchments Using Advanced Machine Learning Algorithms", ISPRS Int. J. Geo-Inf. 2020, MDPI Journal, 9, 569; doi:10.3390/ijgi9100569
[8] Gaurav Verma, Pranjul Mittal, Shaista Farheen, "Real Time Weather Prediction System Using IOT and Machine Learning", 2020 IEEE, 978-1-7281-5493-0/20, doi: 10.1109/ICSC48311.2020.9182766
[9] Onkar Amale, Rupali Patil, "IOT Based Rainfall Monitoring System Using WSN Enabled Architecture", 2019 3rd International Conference on Computing Methodologies and Communication (ICCMC),doi:10.1109/ICCMC.2019.8819721
[10] Meng-Hua Yen, Ding-Wei Liu, Yi-Chia Hsin, Chu-En Lin & Chii-Chang Chen, "Application of the deep learning for the prediction of rainfall in Southern Taiwan", Scientific Reports, (2019) 9:12774, doi: 10.1038/s41598-019-49242-6
[11] M. S. Bennet Praba, Antony John Martin, Siddharth Srivastava, Ajay Rana, "Weather Monitoring System and Rainfall Prediction Using SVM Algorithm", International Journal of Research in Engineering, Science and Management Volume-1, Issue-10, October-2018