FORM-2

THE PATENTS ACT, 1970

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THE PATENT RULES, 2003

(As Amended)

COMPLETE SPECIFICATION

(SECTION 10; RULE 13)

TITLE

ML AIDED IMD ALGORITHMS OVER TELANGANA STATE FOR EXTREME CLIMATE CHANGE PREDICTIONS

APPLICANT

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The following specification particularly describes the nature of the invention and the manner in which it is to be performed.

ML AIDED IMD ALGORITHMS OVER TELANGANA STATE FOR EXTREME CLIMATE CHANGE PREDICTIONS

Field of the Invention

The innovation pertains basically to the field of meteorology and atmospheric sciences with a significant contributions from Artificial Intelligence and Machine Learning. The invention integrates the advanced machine learning techniques with preprocessing and prediction algorithms in order to improve rainfall forecast accuracy. This invention has a very versatile application in the areas of meteorology, agriculture, disaster management, and water resource planning tackling crucial issues in weather prediction and decision-making**.**

Background of the Invention

Rainfall prediction plays an essential role in agriculture as well as in management of disasters and planning of water resources. In developing countries like India where economy is heavily reliant on agriculture, accurate rainfall prediction becomes a critical component whose absence would lead to sub-optimal crop yield or flood-drought associated risks. Rainfall has been predicted traditionally using statistical models or Numerical weather prediction (NWP) systems. Unfortunately, these techniques often cannot take into account the interesting complex, nonlinear relationships involved, resulting in poor prediction capability, especially for localized and extreme events.

Machine learning has emerged as a strong prospective alternative to current techniques and makes it possible to analyze large, heterogeneous datasets or unearth hidden patterns. Such systems often ignore comparative analysis regarding performance of different algorithms or fail to optimize approaches of these systems for specific regional conditions.

This invention uses machine learning algorithms such as Random Forest and Logistic Regression with robust data preprocessing techniques and has demonstrated high accuracy and reliability of rainfall predictions. It integrates all these models under one roof so that informed decision making can be made to sectors of interest in real-world scenarios.

In particular, the CN106405682A patent discloses a method and device which are adopted for predicting rainfalls by means of advanced computation techniques. This invention thus aims to improve the accuracy of rainfall prediction through data collection, processing, and learning techniques. The inputs include temperature, humidity, wind-speed and historical records of rainfall for all the meteorological data to build predictive models. The methodology derives from the analysis of the above input variables to find patterns or correlations which can indicate possible upcoming rainfall events. It is an approach that would not only enhance prediction precision but also real-time updating which makes it valuable for meteorologists or weather forecasting agencies. The patent emphasizes also the integration of user-friendly interfaces into automated systems that enhance dissemination of rainfall predictions to the end user. This includes possible mobile application-wed or web-based platforms through which the public, agriculture, and disaster management agencies can receive the alerts and forecasts in time. This invention gets advantage from machine learning in order to decrease a strong dependency into old way of prediction methods which are useless in fast-changing weather conditions. Overall, this patent CN106405682A is really an advanced innovation in the domain of meteorological prediction-thought it verything provides a highly sophisticated technique to further improve such enhancement.

There exists a patent CN110826810A entitled "apt rainfall forecasting method based on spatial reasoning and machine learning". This invention patent advances rainfall forecasting using machine learning techniques. The improvement in the performance of regional rainfall forecasting is achieved by spatial reasoning, which considers topography, vegetation, water, and other geographical factors important in rainfall patterns. The importance of both spatial factors and climatic variables (temperature, humidity, wind, and pressure) in the model captures all those complex non-linear relations generally missed in the traditional ways.Thus, the ML algorithms use historic and real-time data for localized action-oriented predictions, targeting a specific area rather than any globalized model. The above described is the most useful method in areas with diverse geographies or variable weather patterns, making it more applicable to decision-making with higher accuracy.Applications include agriculture, where they can assist farmers in making better planting schedules;disaster management, which can prepare authorities for any future floods or droughts; and urban planning, where rainfall forecasts would determine how structures are built. It is an invention that significantly improves meteorological forecasting and resource planning. Further applications include.

The hydrological rainfall forecasting system described in KR102282977B1 utilizes machine learning techniques to achieve timely and accurate forecasts of rainfall. It is a real-time processing model for inputs received from various sources such as weather stations, satellites, and sensor networks. It can also adjust itself dynamically according to varying atmospheric conditions. Advanced ML algorithms are used in the identification of complex hydrological variables like rainfall intensity, temperature, humidity, and wind speed. Hence, this model gives it the chance to provide capacity for precise short-term rainfall predictions highly essential in the real-world application. Since its real-time processing capability provides enhanced updating of forecasts, it also caters to time-sensitive activities like disaster preparation, flood management, or irrigation scheduling. By addressing many dynamic, big data sets and providing actionable insights, this invention marks a giant leap in hydrological forecasting, benefiting agriculture, infrastructure planning, and environmental monitoring.

CN114169502A describes an original rainfall prediction process that relies on neural networks (NNs) to describe complex, non-linear relations between climatic parameters like humidity, wind speed, temperature, and atmospheric pressure. Traditional statistical or linear models fail because they cannot accommodate the close relationships they have with one another, usually giving inaccurate rainfall forecasts. On the contrary, neural networks have strong ability in identifying hidden patterns and correlations in large datasets, so they are most suitable for weather forecasting. This method trains such models on previous weather data to understand the effects of such conditions on rainfall. Thus, it can thereafter process new data to provide accurate and reliable rainfall predictions even in highly variable weather conditions. This technique is applicable to different domains, such as agriculture, disaster management, and future water resource planning. It constructs better accuracy and adaptability in decision-making and prevention strategies against climatic adversities.

CN113780377A presents a novel rainfall prediction system designed for IoT-based sensor data integrations and deep learning (DL) algorithms so that granularness and region-specific forecasts can be delivered. It allows the field to offer real-time, localized data on critical parameters like rainfall intensity, humidity, temperature, and wind speed to provide a rich and continuous flow of environmental information. Deep learning algorithms are good at discovering complicated patterns and nonlinear relationships missing in other models. By using historical and real-time data for training, the model becomes good at predicting the specific region's patterns of microclimatic weather conditions and provides very effective and feasible forecasts at local areas. This precise granularity makes the method very applicable to agricultural planning, where it provides accurate rainfall forecasts to facilitate irrigation scheduling and planting cycles. It also applies to urban planning, where localized forecasts assist in flood management and infrastructure design. By improving the accuracy and specificity of such predictions, thus further improving decision-making and resource allocation in sectors dependent on weather, this innovation becomes invaluable.

CN115907201A presents a highly advanced technique for forecasting rainfall through bidirectional Long Short-Term Memory networks, a special type of deep learning architecture for sequential data processing purposes. LSTMs are considered very effective types of prediction because they deal solely with time series or data originating from a point and later predict the future outcome while considering past events. The actual benefit of the bidirectional architecture lies in the fact that it allows the same sequence to be inputted and analyzed in both the forward and backward direction for the same feed, thus bringing the model's study and understanding of temporal dependencies and trends to a higher understanding. This method is specifically meant for short-term rainfall forecasting, providing the forecasted data accurately and on time as it encapsulates the evolving relationships of the weather variables, such as temperature, humidity, and barometric pressure, over time. This system learns from historical weather data in order to identify them to be able to adjust with real-time inputs making the prediction outcome better even under very dynamic conditions. Its high temporal sensitivity makes it immeasurable for applications such as flood warning systems, irrigation planning, and urban infrastructure management, where immediate and localized rainfall predictions are critical to effective decision-making.

Summary of the Invention

This project introduces an innovative rainfall prediction system utilizing machine learning (ML) techniques to enhance forecasting accuracy, specifically for capturing very complex, non-linear relationships within climatic variables. The very geographical based predictions are influenced by looking at CN110826810A, topography, land use, and nearness to water bodies as those are the main geo features that affect rainfall patterns in the area. With the additional spatial data input and climatic variables, such as temperature, humidity, and wind speed, it improves the model's ability to accurately predict a location.It integrates in real-time weather data clearly as in KR102282977B1, by feeding in new data set inputs on the availability from real-time meteorological models such as Random Forest, Logistic Regression. The system is as well going to provide highly localized forecasts by means of IoT-based sensor data as seen in CN113780377A that are important for agricultural planning, urban infrastructure, and disaster management.The system is designed to cater to the preprocessing and features select model comparisons for improving the rain prediction and thereby affording the sectors of weather impacts actionable intelligence. This would then be a new model toward leveraging machine learning to give a better and more accurate reliable forecast on rainfall.

Brief Description of Drawings

The invention will be described in detail with reference to the exemplary embodiments shown in the figures wherein:

Figure-1: Flow chart representing the work flow of the system

Figure-2: Detailed architecture of working of Artificial Neural Network[ANN].

Detailed Description of the Invention

This invention offers an advanced enhanced rainfall prediction system based on machine learning (ML) to improve the accuracy, efficiency, and promptness of rainfall predictions. Conventional rainfall prediction systems are based on statistical methods or numerical weather predictions (NWP) and lack the capability to capture the rich but non-linear relationships between climatic variables and geographic features. They utilize the strength of machine learning algorithms for much more localized rainfall predictions.

The system starts from gathering historical weather data including major climatic variables such as temperature, humidity, wind velocity, topography, and atmospheric pressure together with geographical features such as elevation, topography, land use, and proximity to water bodies. These geographical features are really significant in determining rainfall within specific geographical locations, such as spatial areas that seem to be elevated because they are situated at higher elevations and may receive more rain owing to orographic lifting.

On the other hand, areas around bodies of water might manifest a lot of vapor and rain. The system now takes these spatial features to better account for the regional differences and prediction accuracy at local levels.

Once the data is collected, extensive data pre-processing takes place to get the data ready for machine learning models. Data cleaning, imputation of missing values, normalization, and feature selection enhancement form part of the data pre-processing that results in model optimization. Redundant and irrelevant features have been removed, and data that will be imputed are those that carry an insignificant degree of loss of information. Normalization is done in such a way that all input features are on a comparable scale, thus improving the convergence of models.

5 Claims and 2 Figures

Equivalents

Such equivalent projects include several available systems with machine learning, spatial ability and real-time data integrated into these systems as means of enhancing the weather forecast. One such project is using Support Vector Machines (SVM) or Gradient Boosting Machines (GBM) instead of Random Forest and Logistic Regression for classification and regression tasks. Robustness against complex datasets represents an advantage of such algorithms that could be similarly well at predicting values where climatic variables have non-linear relations.Satellite-based observations or usage of crowd-sourced weather data would be an equivalent to IoT sensors and weather stations, maybe real time and regional oriented data collection. Other alternatives can include Geospatial Machine Learning Models and Geographical Information Systems (GIS), which may offer spatial reasoning.Other possible alternatives can be the use of deep learning techniques, such as Recurrent Neural Networks (RNN) or Convolutional Neural Networks (CNN), as equivalent replacement for capturing sequential or spatial dependencies in the data, thereby improving prediction for short-term rainfall forecasting.

All these alternatives novelly developed predicted rainfall accuracy improvement through machine learning, real-time, and geographical effects, similar to the project's intent.

The scope of the invention is defined by the following claims:

Claim:

The following illustrates the exemplary embodiments of the invention and defines the scope of the invention:

1. A rain fall prediction system at regional levels using machine learning this includes data collection of climatic and geographical features, a preprocessing module, and the models like Random Forest and Logistic Regression for predicition purposes.
2. The system includes a spatial reasoning module enables the server to account for geographical features in their localized predictions.

3. The system processes real-time weather data from IoT sensors and satellite observations for dynamic predictions.
4. A method for predicting rainfall, including data collection, preprocessing, model training, spatial reasoning integration, and performance evaluation.
5. A computer-readable medium containing instructions for performing the rainfall prediction method.

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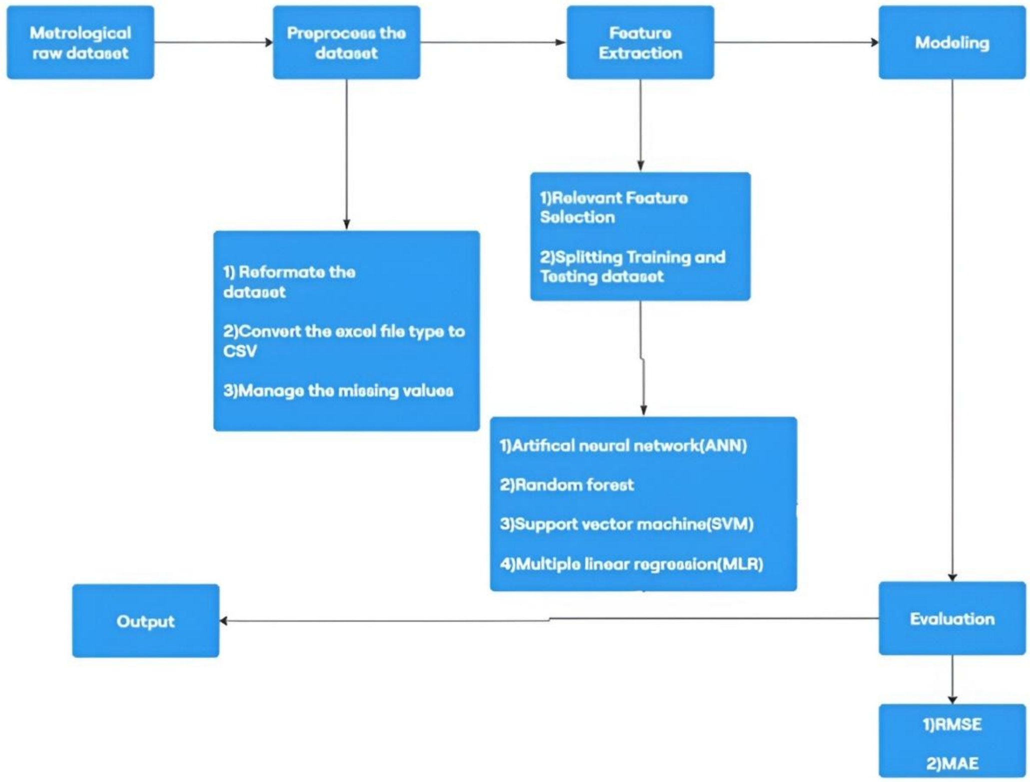

Figure-1: Flow chart representing the work flow of the system

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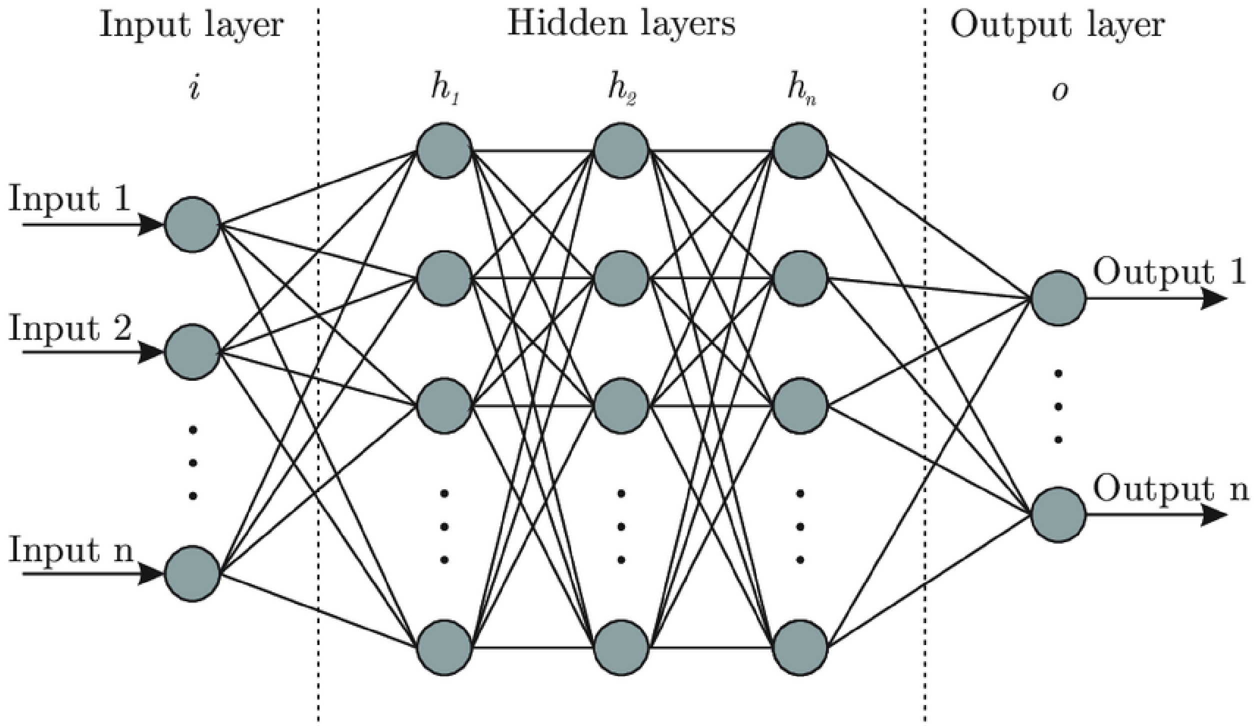

Figure-2: Detailed architecture of working of Artificial Neural Network.

Abstract

Heavy rainfall prediction is a major problem for meteorological department as it is closely associated with the economy and life of human. It is a cause for natural disasters like flood and drought which are encountered by people across the globe every year. Accuracy of rainfall forecasting has great importance for countries like India whose economy is largely dependent on agriculture. Due to dynamic nature of atmosphere, Statistical techniques fail to provide good accuracy for rainfall forecasting. Nonlinearity of rainfall data makes Machine learning a better technique. Review work and comparison of different approaches and algorithms used by researchers for rainfall prediction is shown. Intention of this project is to give non-experts easy access to the techniques and approaches used in the field of rainfall prediction

5 Claims and 2 Figures