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Research Article

Thunderstorms and lightning Detection System using Hybrid Approach

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Abstract

Thunderstorm and lightning is a sudden electrical expulsion manifested by a blaze of lightening with a muffled sound. It is one of the most spectacular mesoscale weather phenomena in the atmosphere . Thunderstorm produce lightening, this kills more people every year than tornadoes, and prediction of thunderstorms is the most complicated task in weather forecasting, due to its limited spatial and temporal extension either dynamically or physically. Various researches are been carried on for forecasting of this severe to reduce damage. Many of the researchers proposed various methodologies like STP model, MOM model, CG model, LM model, QKP model, DBD model and so on for the detection, but neither of them could provide an accurate prediction .The proposed system is to gather the satellite images obtained from dataset in order to predict whether the cloud images produces thunderstorms or not. The present researcher adopted clustering and wavelet transform techniques for Thunderstorms and Lightning Detection using image processing and data mining. The proposed system improves the prediction rate to a greater extent, on the basis of some statistical analysis. For more Accuracy, we are going to do comparative study of different model using Hybrid Approach.

Keywords: *Clustering; Haar wavelet transform; Image processing; Remote sensing; Satellite imagery; Thunderstorm.*

1. Introduction

Thunderstorm is a vicious, climatic disturbance that is associated with heavy rains, lightening, thunders, thick clouds and gusty surface winds. Thunderstorm is a vicious, climatic disturbance that is associated with heavy rains, lightening, thunders, thick clouds and gusty surface winds. Thunderstorms take place when a layer of warm and moist air rises to a larger extent ,and updrafts to the cooler regions of the atmosphere. The updraft that contains moisture condenses in order to form massive cumulonimbus clouds and eventually leads to the formation of precipitation. Columns of frozen air then sink earthward, striking the ground with strong downdrafts and horizontal winds. Meanwhile, electrical charges mount upon cloud particles and causes lightning. This further heats the air in a fierce manner by which shock waves are produced, resulting in thunder .Usually, thunderstorms have the spatial area for a few with a life span less than an hour. However, multi-cell thunderstorms have a life span of several hours and may travel over a few hundreds of kilometers. Thunderstorm is said to be severe when it contains hail measuring of about an inch or more, winds gusting to an extent of 50 knots (57.5 mph). Throughout the world it is estimated that 16 million thunderstorms occur each year, and at any given moment, there are roughly 2,000thunderstorms in progress. There are about 100,000thunderstorms each year in the U.S. alone. About 10% of these reach severe levels. Under the right conditions, rainfall from thunderstorms causes flash flooding, killing more people each year than hurricanes, tornadoes or lightning [2].Cloud to ground lightning frequently occurs as part of the thunderstorm phenomena, which on severity becomes hazardous to the property, wildlife and population across the globe to a major extent. One of the most significant lightning hazards is to the wildfires, as they can even ignite the ground surfaces. Wildfires can devastate vegetation and the biodiversity of an ecosystem.

The thunderstorm identification methodology developed in this paper comprises of four stages. In the first stage, the satellite image is segmented in order to differentiate various textures like water body, forests, grass, asphalt, barren lands, concrete and clouds etc. The segmentation is based onk-means clustering technique in order to extract the thunderstorm features from the original image. In the second stage, Haar wavelet transform [is adopted to acquire square root balance sparsity norm threshold value for the

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feature extracted image. In the third stage, the obtained threshold value is multiplied by wavelength factor to compute a wavelength range of the required image and this range should lie in between 380nm-750nm.

2. Literature survey

1. Himadri Chakrabarty, Murthy C.A, Sonia Bhattacharya and Ashis Das Gupta has used Artificial Neural Network model in order to predict Squall thunderstorms by using RAWIND data. . The present study is performed by the application of artificial neural network Multi-layer Perception (MLP) model to predict seasonal severe thunderstorms associated with squall occurring in Kolkata, India. It is result. The result indicates that forecasting can be done correctly above 98% both for 'squall-storm trained and tested with rawindsonde data recorded in the early morning at 00:00UTC (06:00 Local Time). In this paper, it has been found how much correct prediction of the 'occurrence'/ 'no occurrence' of severe storms can be done using vertical wind shears at different geo-potential heights of the atmosphere having the now casting time of around 12 hours. Multi layer Perception is found to yield very promising days' and 'no storm days'.

2. Litta A.J, Sumam Mary Idicula and Naveen Francis C has adopted multilayer perception network model to predict thunderstorms where in, the prediction was done using the data obtained from RSRW flight but this is limited to a particular region rather than the entire world prediction over Kolkata. In this, experiments are conducted on artificial neural network (ANN) model to predict severe thunderstorms that occurred over Kolkata on 3 May 2009, 11 May 2009 and 15 May 2009 using thunderstorm affected parameters and validated the model results with observation. The performance of ANN model in predicting hourly surface temperature during thunderstorm days using different learning algorithms are evaluated. A statistical analysis based on mean absolute error, root mean square error, correlation coefficient and percentage of correctness is performed to compare the predicted and observed data. The results show that the ANN model with Liebenberg Marquardt algorithm predicted the thunderstorm activities well in terms of sudden fall of temperature and intensity as compared to other learning algorithms.

3. Harvey Stern has used a knowledge based system to predict thunderstorms. This study describes the environmental atmospheric characteristics in the vicinity of different types of severe convective storms in Europe during the warm seasons in 2006 and 2007. 3406severe weather events from the European Severe Weather Database ESWD were investigated to get information about different types of severe local storms, such as significant or weak tornadoes, large hail, damaging winds, and heavy precipitation. These data were combined with EUCLID (European Cooperation for Lightning Detection) lightning data to distinguish and classify thunderstorm activity on a European scale into seven categories: none, weak and 5types of severe thunderstorms. Sounding parameters in close proximity to reported events were derived from daily high-resolution T799 ECMWF (European Centre for Medium-range Weather Forecasts) analyses.

4. Rudolf kaltenbock, Gerhard Diendorfer and Nikolai Dotzek has analyzed ECMWF, lightning data and severe storm reports for the evaluation of thunderstorms. In this, one meteorological case study for two Iranian airports are presented. Attempts have been made to study the predefined threshold amounts of some instability indices such as vertical velocity and relative humidity. Two important output variables from a numerical weather prediction model have been used to survey thunderstorms. The climatologically state of thunder days in Iran has been determined to aid in choosing the airports for the case studies.

5. Tajbakhsh S, Ghafarian P, and Sahraian F has adopted numerical weather prediction modelin order to survey thunderstorms Natural calamities cause heavy destruction to both life and property. Prediction of such calamities well in advance is inevitable. Prediction and classification of thunderstorms using Artificial Neural Network (ANN) is presented in this paper. The Numerical Weather Prediction (NWP) models used today suffer from course resolution and inaccuracy. Two geographical locations are considered for our study namely, Paradeep in the west cost of India and Wollemi National Park, New South Wales, (Australia). ANN has designed to forecasts the occurrence of thunderstorm in these regions. Input parameter selection is very critical in ANN design, Eight input parameters were identified to train the network. The output nodes clearly classifies the days with and without thunderstorms, thus successfully predicting thunderstorm activity in the specified regions.

6. Mahesh Anand S, AnsupaDashi, Jagadeesh Kumar, Amit Kesarkar has adopted artificial neural network model for the prediction of thunderstorms By using verification parameters such as the True Skill Statistic (TSS) and the Heidke Skill Score (Heidke), optimal thresholds and relative forecast skill for all thunderstorm predictors have been evaluated. It was found that Heike reaches a maximum for more thundery index values than thetas. In order to arrive at a single optimal threshold value, the TSS and Heidke were combined to form the Normalized Skill Score (NSS).

7. Alwin Haklander, Aarnout Van Delden has discussed how pressure, temperature, moisture and wind data from a single rawinsonde observation at DE Bilt. It can be used as an aid in estimating the probability of thunderstorm occurrence within 100km from De Bilt during the sounding.

8. Pinto has discussed annual values of thunderstorm days and annual temperature values in the city of Sao Paulo. In consequence, its ability to predict future climate changes in the thunderstorm activity depends

on a better understanding of the climate system as awhile and the external factors that could be involved such as volcanic eruptions and solar variations, as well as human-induced changes in atmospheric composition. Such an understanding can only be achieved through a greater ability to document and explain observed past variations. The study changes offered the opportunity to gain a better understanding of atmospheric electricity. Also, the possibility that, as the global warming continues to evolve, increasing evidence of thunderstorm changes are found, will help to understanding the climate system.

9. Alan Czarnetzki C has discussed about nocturnal thunderstorms, which produces heavy rains this study used late afternoon and early evening observations to identify these precursors, limiting the lead time of a forecast to a few hours.

3. Experimental Methodology

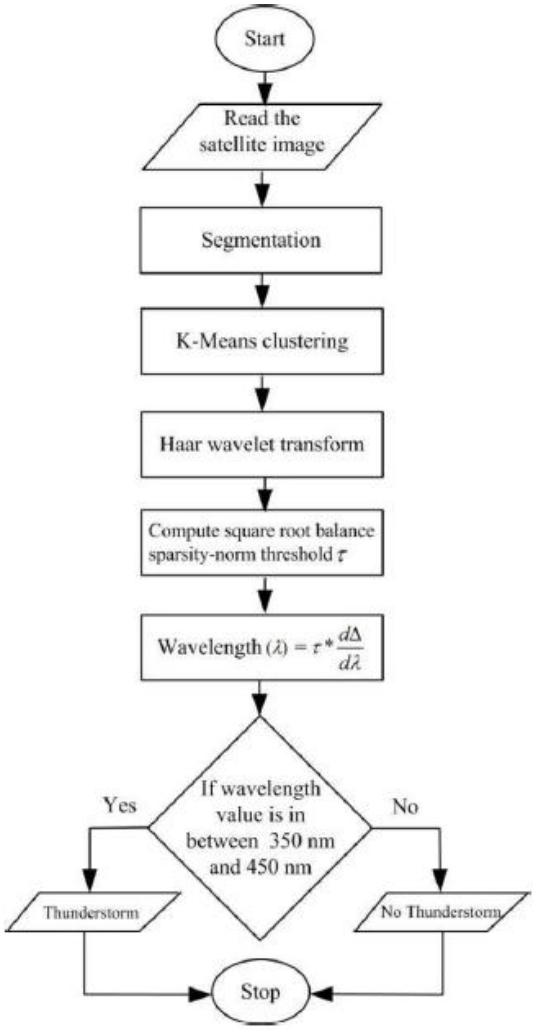

Fig. 1 Procedure for detecting the thunderstorms

The goal of this real time processing is to collect the satellite images obtained from Indian Meteorological Department, in order to predict whether the cloud images produces thunderstorms or not. Initially, the original satellite image of clouds is taken as the input image for the experimentation. As the input image is a satellite image, it may contain with different type of noises such as striping noise, speckle noise, blurs and so on which are ought to be removed. It may also contains various texture such as water bodies, forests, grass, asphalt, barren lands, concrete, clouds and so on. These textures are to be estranged to acquire the image of interest so that the other texture does not have an effect on the precise forecasting of thunderstorms. If the satellite image containing such types of noises and textures are analyzed, the result obtained may deviate from original value. So, the input image must b segmented. In the present research, k-means clustering is adopted for segmenting the image. Here, Segmentation is Performed to image by based on various color factors because colors possess wavelength values. The image containing relatively similar wavelength values are grouped into different clusters the Haar wavelet transform is adopted for the further analysis where decomposition is applied to the image in rows and columns by transforming from data space to wavelet space in frequency domain. As a satellite image is an RGB image, Haar wavelet transform automatically converts RGB image into gray scale image and further de noise the image and present it in one dimension. Here wavelength factor value is to be computed and for obtaining next value of wavelength, multiplying previous wavelength value and square root balance sparsity norm threshold value Here, a constant wavelength factor value is considered for the calculation of wavelength range. The constant wavelength factor value is the mean value. As the cloud satellite image is a visible infrared spectrum, its wavelength range would lie in between 380 nm - 750 nm it can be observed that whenever a thunderstorm image is present, wavelength lies in between380nm to 480nm which falls in the visible range. By experimentation, it is established that every thunderstorm image comprises a wavelength in between 380nm to 480nm,

The four basic performance measures i.e. sensitivity, specificity, accuracy and precision are computed for the present research in order to test how well the proposed system is working. The computations are done by using following equations

$$Sensitivity = \frac{TP}{TP + FN}$$

$$Specificity = \frac{TN}{FP + TN}$$

$$Accuracy = \frac{TP + TN}{TP + FP + FN + TN}$$

$$\text{Pr}\,ecision = \frac{TP}{TP + FP}$$

Conclusions

In this topic we have been conducted with various hybrid algorithm for the prediction of thunderstorms. It was demonstrated that the resulting mechanism out

performs the previous methods such as STP model, MOM model, CG model, LM model, QKP model, DBD model in the detection of thunderstorms. In order to compute accuracy, the four basic performance measures i.e. sensitivity, specificity, accuracy and precision are computed. The proposed method predicts the thunderstorms with an average accuracy of 89.23%.

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