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A Review on Prediction and Analysis of Forest Fires Using AI and ML Algorithms

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Abstract: ***Forest fires or wildfires are major catastrophes that occur in forests, grasslands, or prairies (Grassland areas). Wildfires mostly occur either due to natural factors or human activities such as smoking cigarettes, campfires, or arson, etc. Forest fire has become one of the most drastic problems that cause damage to several forests around the globe. To prevent forest fires, analysis, and predictions should be made on land that is affected by forest fires based on temperature, wind, humidity, etc. Depending upon the above factors, analysis, and prediction are done, which region has a high possibility of wildfires' dangerous effects. Fire detection will help in finding and controlling an extreme problem in forests, this will help in reducing the forest fire in the future. Many Algorithms are available for the detection of the fire, Based on the use of Algorithms analysis and prediction of the forest fires are made.***

Keywords: Forest fire, Wildfire, Analysis, Forest fire detection, Forest fire prediction

I. INTRODUCTION

Forests are large, dense areas dominated by trees and vegetation. Forest provides food, shelter, and clothes, and is a major source of oxygen. However, forests are extremely susceptible to fire, which can have a huge negative impact on the environment, economy, and society.

In recent years, many species have lost their lives, soil erosion and loss of vegetation have increased and infrastructures and properties have been damaged mainly due to forest fires. In addition, wildfires have caused air pollution, respiratory problems, cardiovascular issues, and eye problems to people. Therefore, significant measures need to be taken to prevent wildfires.

The main purpose of the study is to compare and review ten different papers, where each author has proposed different algorithms and methodologies to predict forest fires more accurately.

II. RELATED WORKS

Xufeng Lin et al. [1] put forward an LSTNet algorithm to detect through remote sensing satellites and GIS. The study area is situated in Chongli district, china. The proposed architecture made use of a convolution layer, a recurrent layer, and a recurrent-skin layer to detect results. The model was trained with a prediction map with ACC, and RMSE metrics. The best results were obtained from CIMISS, GCS_WGS_1984 coordinates.

Veerappampalayam Easwaramoorthy Sathishkumar et al. [2] put forward a Convolution Neural Network (CNN) to classify input of surveillance systems obtained from camera trap networks for wildlife monitoring and analysis. There are many techniques used for smoke detection and fire for example sensor based etc. Simple color features are used for the false alarms and computer vision-based technology was used to recognize them and further predict their smoke images or fire. Various state-of-art machine learning algorithms such as SVM, decision trees, and neural networks were used for classification. BPNN was trained using both balanced and unbalanced datasets. For unbalanced datasets, a high proportion was used along with the non-fire images to measure the performance. An accuracy of 98.72% was reported with a perfect 100% during initial training.

Chao Gao et al. [3] used a random forest (RF) and Back propagation neural network (BPNN) to predict the forest fires at the north western. The datasets were divided into training sets and validation sets. Two machine learning methods were used i.e., prediction accuracies, and AUC values. The BPNN can be optimized using network topology learning rate and threshold. Qualities of results were measured using accuracy, precision, and recall. The accuracy ranged from six significant forest fire driving factors. Made use of Convolution Neural Network (CNN) supplemented by support vector machines. The result was obtained from perception and relative humidity. Support Vector Machines and artificial neural networks were used as a classifier.

Bhogendra Mishra et al. [4] suggested a spatiotemporal dimension by combining the set of weights. Model evaluation has been performed. The required data was collected from the Kaggle with data used for training and testing. A comparative study was carried out using forests in South Korea. It was concluded that the DNN model came out to be the most successful one among others.

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Akshatha V et al. [5] proposed a Deep Learning method based on a convolution neural network (CNN). The datasets were used as images after collecting we are pre-processing for training and testing to classify datasets using the CNN algorithm and we can get the output as fire is present or not. And support vector machine (SVM) and KNN were used as a classifier. To extract features several CNN such as ResNet50 were used. Complex data using CNN were used in the form of text, images, or sound. The number of cycles of the epoch was used to train the machine learning model. Introduced the Resnet-50 model, it proposed accurate rate and is feasible, Resnet-50 extract structure. It will stay away from false alarms. The accuracy rate reached 93% which is the best.

Kajol R Singh, and K.P et al. [6] used Indian Meteorological Department and UCI with a Support Vector Machine, Parallel Support Vector Machine, and PySpark model. It divides the training dataset into subsets and combines the first and second layers from support vectors. Big data analysis can handle distributed framework and this model makes it more efficient and reliable. Communicate between client and server for request responses that use Django and in the background it will run the programs to predict the forest fire. Predicts, alerts, Intensity, and Validation were divided into results in this we have an automated alert.

Preeti T et al. [7] came forward with Decision Tree, SVM, Random Forest Regression, and ANN, to detect forest fires at the order level. The required data were collected from the Kaggle with 517 observations and 13 variables in the European Republic. After data pre-processing it is formed in a standard format and a suitable model was selected based on the dataset for data preparation, pre-processed data were plotted correlation matrix between the correlations between metrological data like relative humidity, wind speed, temperature, and rain two variables measures and move together.

Ahmed M. Elshewey et al. [8] made use of Linear Regression, Ridge Regression, and Lasso Regression supplemented by k-means to detect fires. To extract features several Data mining such as data collection, data pre-processing, data analysis, and data post-processing were used, and Support Vector Machine (SVM) and KNN were used as a classifier. In machine learning algorithm, linear regression for predicting variables such as temperature, and humidity and show the outperformed result in accuracy, ridge regression is a variation of linear regression and minimizes the model of the complexity, when applied to the lasso regression it shows the highest accuracy score overall. After performing multiple tests, the linear regression algorithm showed the best result.

Mochammad Anshori et al. [9] proposed ELM, Random Forest Regression, Linear Regression, and Support Vector Regression. In machine learning the first step is data collection using collecting relevant data based on satellite imagery and remote sensing technologies, the next step is collecting relevant features i.e., Feature Selection which reduces dimensionality and improves accuracy, and Model selection like different types of models like decision tree, support neural network, and neural network which can be trained on the pre-processed data for accurate predictions. It is the process of selecting and transforming the data that can be easily analyzed.

B.K. Singh et al. [10] suggested Extreme Learning Machine (ELM) and the study area located in Lam Dong, Vietnam. It firstly acquires the data of forest fire and then normalizes and then divides the datasets it develops the ELM model and decides on neurons from the hidden layer. The Database has ten attributes and the confusion matrix was recorded for each. The confusion matrix was proposed for the ELM. The best precision result comes with the ROC curve and confusion matrix. Among the five activations tested the sigmoid function shows outperformance while the hardlim function has poor performance, so the sigmoid function is suggested for forest fire prediction.

III. COMPARISON AMONG MODELS

Table 1 includes a comparison among models based on datasets, methods, algorithms, and results.

TABLE-1: Comparison Among Models

References	Datasets/Study Areas	Methods and Algorithms	Outcomes
Xufeng Lin et al. [1] 2023	Chongli District – remote sensing data and meteorological data	Pearson analysis, Multicollinearity Test, Long-and Short-term Time-series Network(LSTNet), CNN, Recurrent Component, Recurrent Skip Component, and Autoregressive Component	Accuracy = 0.941

Veerappampalayam Easwaramoorthy Sathishkumar et al. [2] 2023	Satellites(Geostationary weather satellites including MODIS, VIIRS, Copernicus Sentinel-2 and Landset-8), Images from Google and Kaggle, The BoWFire dataset	Convolution Neural Network, VGG-16, Xception, Transfer Learning, Feature Extractor, Fire-Tuner, and Learning Without Forgetting	Accuracy = 98.72 for Xception based model
Chao Gao et al. [3] 2023	China Meteorological DataSharing Network, National Geographical Information Resource Directory Website, and Geospatial Data Cloud of China	Random Forest Algorithm, Backpropagation Neural Network Algorithm, SVM, RF Importance Evaluation, and Logistic regression and ROC	Accuracy = between 86.01% and 88.98% AUC Value = between 0.930 and 0.955
Bhogendra Mishra et al. [4] 2023	Kaggle (Bioclimatic(worldclim), Topographic(USGS, GTOP030),Vegetation-related(GEOFABRIK,MODIS, 13Q1,ICIMOD Land Cover), Anthropogenic(SEDAC, GEOFABRIK), Survey Departmental Nepal, Livestock, and Geowiki)	Maximum Entropy(Maxent) and Deep Neural Network(DNN)	Maxent = 90% area under very low risk and DNN = 83.78% area under very low risks. DNN showed many area under higher risks compared to Maxent (2.64% versus 0.27%)
Akshatha V et al. [5] 2022	Images from Internet	Deep Learning and CNN	Accuracy = 93%
Kajol R Singh, and K.P et al. [6] 2021	Indian Meteorological Department and UCI	Support Vector Machine, Parallel Support Vector Machine, and PySpark model	Parallel SVM model = 63.45 RMSE and SVM = 63.5 RMSE
Preeti T et al. [7] 2021	Kaggle(natural park of Montesano in European Republic)	Decision Tree, SVM, Random Forest Regression, and ANN	MAE = 0.03, MSE = 0.0004 and RMSR = 0.07
Ahmed M. Elshewey et al. [8] 2020	Montesinho Natural Park in Portugal	Linear Regression, Ridge Regression, and Lasso Regression	Accuracy score in training dataset = 1, 0.98 and 0.98 Accuracy score in testing dataset = 1, 0.95 and 0.81
Mochammad Anshori et al. [9] 2019	Montesinho Natural Park in Portugal	ELM, Random Forest Regression, Linear Regression, and Support Vector Regression	Accuracy = 63.09511 RMSE
B.K. Singh et al. [10] 2019	Lam Dong, Vietnam	Extreme Learning Machine(ELM)	Accuracy: SinC function = 85.42%, Radial Basis Function = 84.95% and Hardlin Function = 77.08%

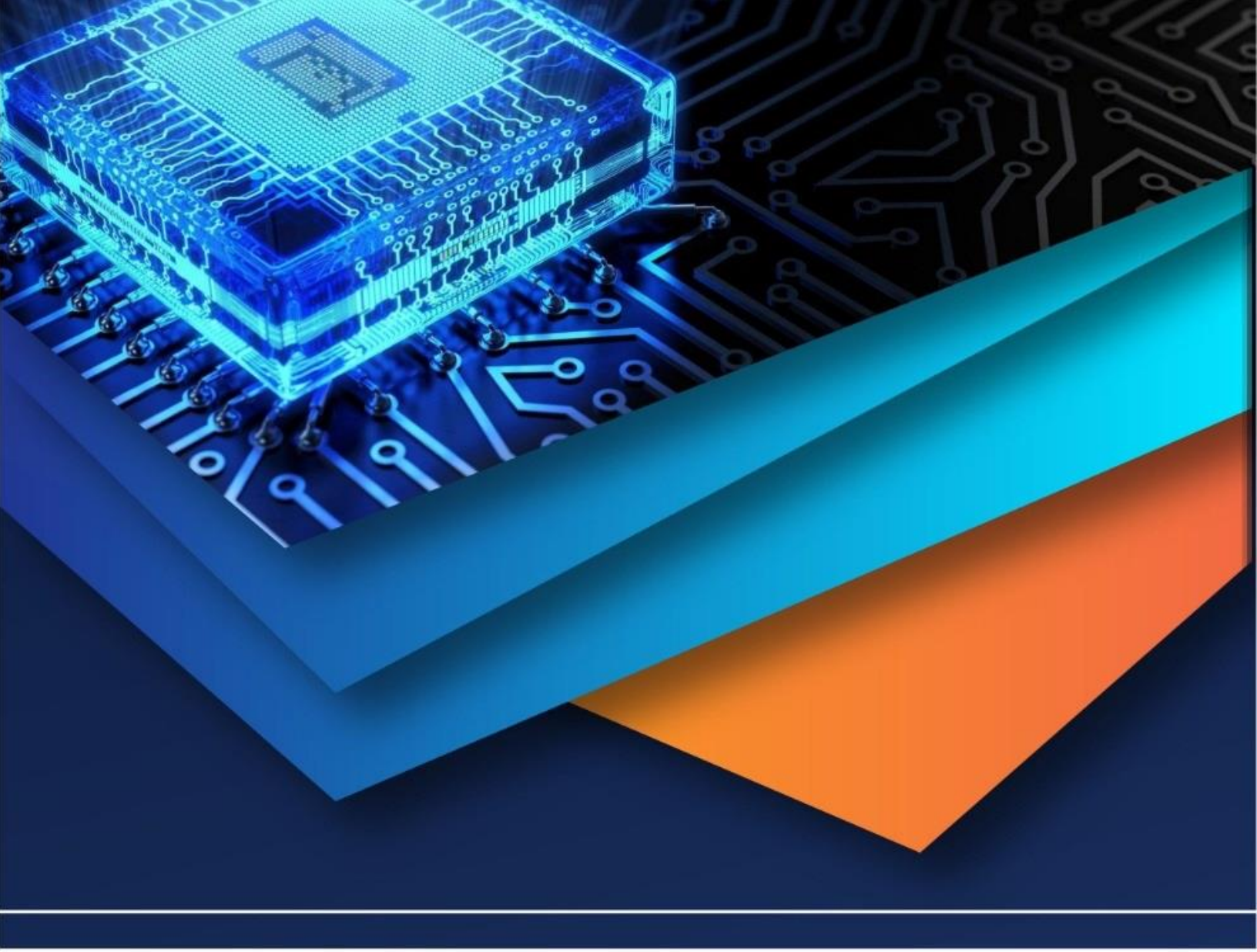
IV. CONCLUSION

The causes of forest fires have been increasing fairly, the problem is mainly caused by the growing population of humans. As humans will arrive in the forest frequently and collect wood, timber, etc, resources of the forest. 90% of forest fires in India are man-made, catastrophic wildfires are deadly costly, and destructive. We illustrated several researchers who are engaged in the field of forest fire Analysis and Prediction during the survey based on the available resources.

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