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FOREST FIRE DETECTION USING CONVOLUTIONAL NEURAL NETWORK

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Abstract: Forest fires are a matter of concern because they cause extensive damage to environment, property and human life. Hence, it is crucial to detect the forest fire at an earlier stage. This can help in saving flora and fauna of the region along with the resources. Also, it may help to control the spread of fire at initial phase. The task of monitoring the forests is difficult because of the vast territory and dense forest. Detection of forest fire should be fast and accurate as they may cause damage and destruction at a large scale. The forest fire has become a threat to not only to the forest wealth but also flora and fauna and ecology of the environment of the region. The main cause of forest fires can be categorized under natural and man-made classes. High atmospheric temperature, lightening and dryness (low humidity) offer positive environment for a fire to start which are the natural causes for forest fire.

I. INTROUDCTION

Fire is an important ecosystem process and has played a complex role in terrestrial ecosystems and the atmosphere environment. Sometimes, wildfires are highly destructive natural disasters. To reduce their destructive impact, wildfires must be detected as soon as possible. However, accurate and timely monitoring of wildfires is a challenging task due to the traditional threshold methods easily be suffered to the false alarms caused by small forest clearings, and the omission error of large fires obscured by thick smoke. Deep learning has the characteristics of strong learning ability, strong adaptability and good portability.

Objectives

- To devise an algorithm which can help to detect forest fire in its early stage.
- To make the probability of false alarms reduced.
- To build a system which is energy efficient in distributed environment and also efficient in performance.

- **PRELIMINARY ANALYSIS & INFORMATION GATHERING**
- Forest fires can often be detected by trained personnel or observers who visually scan forest areas for signs of smoke or flames. This can be done from lookout towers, aircraft, or on the ground.
- Remote sensing techniques, such as using satellites or aircraft equipped with sensors, can detect heat signatures or smoke plumes associated with forest fires. These sensors can capture thermal or infrared images, which can be analyzed to identify potential fire hotspots.
- Monitoring weather conditions, such as high temperatures, low humidity, and strong winds, can help predict and detect forest fires. These weather factors can create favorable conditions for fire ignition and spread, and monitoring weather patterns can provide early warning signs of potential fire risk.
- Sensors deployed on the ground, such as temperature sensors or smoke detectors, can detect changes in environmental conditions that may indicate the presence of a forest fire. These sensors can be installed strategically in forest areas or near human settlements to provide early detection of fires.
- Local communities, including residents, hikers, or forest workers, can report forest fires when they observe smoke or flames. Prompt reporting to relevant authorities can help in early fire detection and response.
- Fire towers and cameras strategically located in forested areas can provide visual monitoring for signs of smoke or flames. These can be manned lookout towers or automated camera systems that continuously monitor forest areas for fire activity.
- Aerial patrols using helicopters or airplanes equipped with fire detection sensors or trained observers can fly over forested areas to detect signs of forest fires, such as smoke or flames.

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II. LITERATURE SURVEY

1.Forest Fires Detection Using Machine Learning Techniques
Ahmed M. Elshewey
Nowadays, forest fires became one of the foremost important problems that cause damage to several areas around the world. The paper displays machine learning regression techniques for predicting forest fire-prone areas. The data set used in this paper is presented within the UCI machine learning repository that consists of climate and physical factors of the Montesinos park in Portugal. This research proposes three machine learning approaches, linear regression, ridge regression, and lasso regression algorithm with data set size 517 entries and 13 features for each row. This paper uses two versions, all features are included in the first, and 70% of the features were included in the second. The paper uses a training set which is 70% of the data set, and the test set is 30% of the data set. The accuracy of the linear regression algorithm gives more accuracy than ridge regression and lasso regression algorithms.

2. FOREST FIRE DETECTION USING MACHINE LEARNING
Pragati1, Sejal Shambhuwani2, Piyusha Umbrajkar3
Detection of forest fire should be fast and accurate as they may cause damage and destruction at a large scale. Recently, Amazon forest confronted a devastating forest fire which remained obscured for over 15 days. Hence resulting in huge loss of ecosystem and adversely affecting the global conditions. As the technology is developing, Wireless Sensor Networks (WSN) is gaining importance in recent research areas as it has shown its usefulness in warning disasters and save lives[1]. As soon as an unusual event is noticed in the networks, an event is detected through the sensor devices placed at distributed locations. This event detection information is passed to the base station and decision is taken. Due to the static configuration of such sensor data in WSN generally lead to false alarm generation [2]. In such a scenario we can use machine learning algorithms to prevent false alarm since they get configured efficiently in dynamic nature, that too automatically .Therefore for eliminating the static essence of WSN, we present a machine learning algorithm imbibed with WSN. In this paper, we propose a decision tree machine learning approach for detecting events.

3. Detection of Forest Fires using Machine Learning Technique: A Perspective
Aditi Kansal1, Yashwant Singh2, Nagesh Kumar3, Vandana Mohindru4
Wireless Sensor Networks (WSN) has gained attention as it has been useful in warning about disasters. Predicting natural disasters like hailstorm, fire, rainfall etc. by WSN are infrequent and stochastic. This is an important topic of Research. Detection of these disasters should be fast and accurate as they may cause damage and destruction at a large scale. In this paper, comparison of various machine learning techniques such as SVM, regression, decision trees, neural networks etc. has been done for prediction of forest fires. The proposed approach in this paper presents how regression works best for detection of forest fires with high accuracy by dividing the dataset. Fast detection of Forest fires is done in this paper by taking less time as compared to other machine learning techniques.

4. Forest fire detection system using wireless sensor networks and machine learning
Udaya Dampage *, Lumini Bandaranayake, Ridma Wanasinghe, Kishanga Kottahachchi & Bathiya Jayasanka
Forest fires have become a major threat around the world, causing many negative impacts on human habitats and forest ecosystems. Climatic changes and the greenhouse effect are some of the consequences of such destruction. Interestingly, a higher percentage of forest fires occur due to human activities. Therefore, to minimize the destruction caused by forest fires, there is a need to detect forest fires at their initial stage. This paper proposes a system and methodology that can be used to detect forest fires at the initial stage using a wireless sensor network. Furthermore, to acquire more accurate fire detection, a machine learning regression model is proposed. Because of the primary power supply provided by rechargeable batteries with a secondary solar power supply, a solution is readily implementable as a standalone system for prolonged periods. Moreover, in-depth attention is given to sensor node design and node placement requirements in harsh forest environments and to minimize the damage and harmful effects caused by wild animals, weather conditions, etc. to the system. Numerous trials conducted in real tropical forest sites found that the proposed system is effective in alerting forest fires with lower latency than the existing systems.

1. Forest Fires Detection Using Machine Learning Techniques
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III METHODOLOGY

1. PROPOSED METHODOLOGY

To reduce the destructive impact of wildfires, it is crucial to detect the active fires accurately and quickly in the early stage. Machine learning techniques, such as Convolutional Neural Networks (CNNs), have emerged as a promising approach for automated forest fire detection.

A machine learning project for detecting forest fires using CNNs typically involves training a deep learning model on a large dataset of labeled images of forests or forested areas. CNNs are a type of neural network that are well-suited for image processing tasks, as they can automatically learn to extract relevant features from images. By training a CNN model on a diverse and representative dataset of forest fire images, the model can learn to recognize patterns and features indicative of forest fires, such as smoke, flames, or changes in vegetation color.

CNN-based forest fire detection systems have the potential to provide several advantages, including improved accuracy, timeliness, and coverage compared to traditional methods. They can operate autonomously, continuously monitor large forested areas, and provide early warning of forest fires, allowing for faster response and mitigation efforts.

CNN Algorithm

The CNN algorithm is used to achieve the same and cross validated. The Cross Validation is a technique for evaluating machine learning models by training on subsets of dataset and evaluating on complementary subsets of dataset. In this CNN model, k-fold cross-validation divides the dataset into k parts of equal size, one part is kept for validation and remaining parts are used for training.

CONVOLUTIONAL LAYER

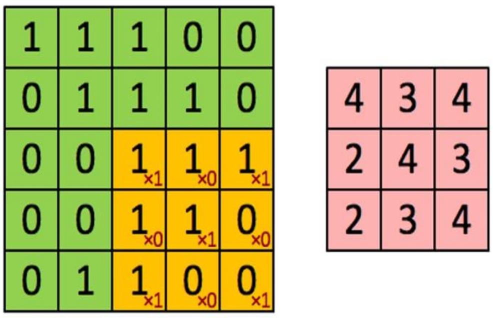
It always comes first. It receives the image (a matrix of pixel values). Assume that the input matrix's reaction starts at the top left of the image. The software then chooses the smaller matrix there, which is referred to as a filter. The filter then generates convolution that moves over the input image. The filter's job is to multiply the original pixel values by its value. All of these multiplications are added together, yielding a single number. The filter moves because it only reads the image in the upper left corner. Additionally, one unit on the right performs a similar operation. A matrix is created after passing the filter through all points, however it is less than the input matrix. From a human standpoint, this operation is comparable to distinguishing visual boundaries and simple colors. However, in order to recognize the fish, the entire network is required. Several convolution layers will be blended with nonlinear and pooling layers in the network. The first layer to extract features from an input image is convolution. Small squares of input data are used in convolution. It's a mathematical procedure with two inputs: an image matrix and a filter or kernel.

- Dimension of an image matrix (h x w x d)
- A filter (fh x fw x d)
- Outputs a dimension (h-fh+1) x(w-fw+1) x1

Consider a 5 x 5 whose image pixel values are 0, 1 and filter matrix 3 x 3 as shown in below

Convolution with a filter example

Then the convolution of 5 x 5 image matrix multiplies with 3 x 3 filter matrix which is called "Feature Map" as output shown in below



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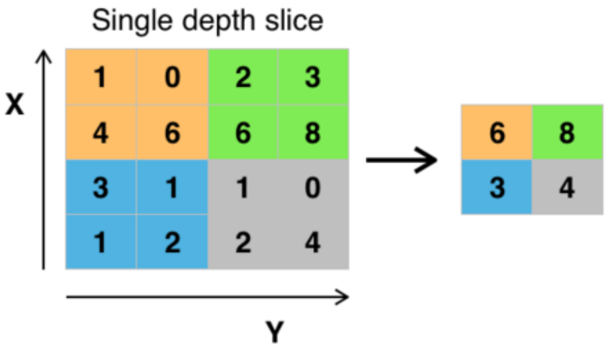
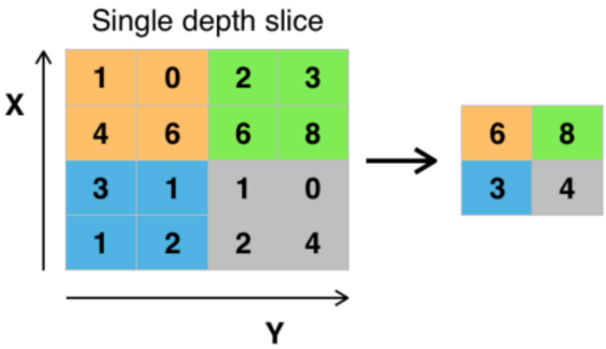
THE NON-LINEAR LAYER:

After each convolution process, it is adder. It features an activation function that provides a nonlinear property; without this trait, a network would be insufficiently intense and unable to simulate the response variable.



It moves in the same direction as the nonlinear layer. It works with the image's width and height, performing a down sampling procedure on them. As a result, the size of the image is lowered. This means that if some features were already recognized during the previous convolution operation, a detailed image is no longer required for further processing and is reduced into smaller images.



FULLY CONNECTED LAYER:

It's primary to link an overall linked layer after completing the succession of convolution, non-linear, and pooling layers. This layer receives the convolution network's output data. When a completely connected, layer is attached to the network's end, it produces an N-dimensional vector, where Ni is the number of classes from which the model chooses the needed class.

CNN MODEL

- The TensorFlow framework and the OpenCV library were used to create this CNN model, which is widely utilized in real-time applications.
- This concept can also be used to create a full-fledged software that scans everyone entering a public meeting.

LAYERS IN CNN MODEL

1. Conv2D Layer
2. MaxPooling2D Layer
3. Flatten () Layer
4. Dropout Layer
5. Dense Layer

1. Convo2D Layer:
It has 100 filters and the activation function used is the ‘ReLu’. The ReLu function stands for Rectified Linear Unit which will output the input directly if it is positive, otherwise it will output zero.

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2. MaxPooling2D:
It is used with pool size or filter size of 2*2.
3. Flatten () Layer:
It is used to flatten all the layers into a single 1D layer.

4. Dropout Layer:
It is used to prevent the model from overfitting.

5. Dense Layer:
The activation function here is SoftMax which will output a vector with two probability distribution values.

IV.CONCLUSION

In conclusion, the use of Convolutional Neural Networks (CNNs) for detecting forest fires in machine learning projects holds great promise. CNNs have shown significant advantages over traditional methods for forest fire detection, including higher accuracy, real-time or near real-time operation, scalability, autonomy, adaptability, early warning capabilities, and potential for automation. By leveraging the power of deep learning and image processing, CNN-based forest fire detection systems have the potential to enhance fire management and mitigation strategies, leading to more effective and efficient forest fire detection and response.

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