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Original Article

Emerging Methods for Early Detection of Forest Fires Using Artificial Intelligence

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Abstract: *Forest fires are one of the natural disasters that happen the most frequently today. Forest fires are a matter of concern because they cause extensive damage to environment, property and human life. By doing this, the region's resources and flora and fauna may both be saved. In particular, we proposed a platform of Artificial Intelligence. The use of computer vision techniques for smoke and fire detection and recognition based on still photos or video input from the cameras. This will enable the video surveillance systems on forest to handle more complex situations in real world. Deep learning method "convolution neural network" can be used forfinding the amount of fire. This will enable the video surveillance systems on forest to handle more complex situations in real world. The accuracy isbased on the algorithm which we are going to use and the datasets and splitting them into train set and test set.*

Keywords: *Artificial intelligence, Machine learning, Forest fires, Algorithms.*

I. INTRODUCTION

Wildfire, also called wild land fire, uncontrolled fire in a forest, grassland, brush land, orland sown to crops. The terms forest fire, brush fire, etc., may be used to describe specific types of wildfires; their usage varies according to the characteristics of the fire and the region in which it occurs. The wide ranging adverse ecological, economic and social impacts of forest fires includingforest degradation are:

- Loss of valuable wood resources.
- Deterioration of catchment areas.
- Loss of biodiversity and extermination of flora andfauna.
- Loss of wildlife habitation and exhaustion ofwildlife.
- Global warming.

Fire danger in a wild land setting varies with weather conditions: drought, heat, and wind participate in drying out the timber or other fuel, making it easier to ignite. Once a fire is burning, drought, heat, and wind all increase its intensity.

Topography also affects wildfire, which spreads quickly uphill and slowly downhill. Dried grass, leaves, and light branches are considered flash fuels; they ignite readily, and fire spreads quickly in them, often generating enough heat to ignite heavier fuels such as tree stumps, heavy limbs, and the organic matter of the forest floor.

Such fuels, ordinarily slow to kindle, are difficult to extinguish. Green fuels—growing vegetation—are not considered flammable, but an intense fire can dry out leaves and needles quickly enough to allow ready ignition. Green fuels sometimes carry a special danger: evergreens, such as pine, cedar, fir, and spruce, contain flammable oils that burst into flames when heated sufficiently bythe searing drafts of a forest fire.

Tools for fighting wildfires range from the standard equipment of urban fire departments to portable pumps, tank trucks, and earth-moving equipment. Firefighting forces specially trained to deal with wildfires are maintained by public and private owners of forestlands. Such a force may attack a fire directly by spraying water, beating out flames, and removing vegetation at the edge of the fire to contain it behind a fire line.

When the very edge is too hot to approach, a fire line is built at a safe distance, sometimes using strip burning or backfire to eliminate fuel in the path of the uncontrolled fire or to change the fire's direction or slow its progress. Backfiring is used only as a last resort. Prescribed fires, in which controlled fires are intentionally set to decrease the fuels in a given area and to promote the health of fire- adapted ecosystems, can be used to prevent or mitigate wildfires. The goal of the system is to identify the possible dangers by continuously record the forest, by processing segments of the recorded signals and decide upon the nature of each of these segments. It is important to move adequate fire equipment and qualified operational manpower as fast as possible to the source of the fire. Furthermore an adequate logistical infrastructure for sufficient supply with extinguishing devices and maintenance is necessary as well as continuous monitoring of fire spread. An integrated approach for forest fire detection and suppression is based on a combination of different detection systems depending on wildfire risks, the size of the area and human presence, consisting of all necessary parts such as early detection,

remote sensing techniques, logistics, and training by simulation, and firefighting vehicles.

Figure 1: Mitigate Wildfires

There are different systems that are used for the detection of domestic and forest fires. Various alarm systems are being used today for fire detection and warning purpose. In this project, we focus on employing various machine learning techniques on a system based on wireless sensor networks. There area number of advantages of using machine learning algorithms with WSNs. If we can successfully predictthe onset of the fire, a lot of damage will be reduced and environmental degradation will be decreased.

Many forest areas do not have fire alarm systems installed. Fire alarms are important because they can alert you before a tragedy happens. You can,therefore, stay prepared, take necessary actions and reduce any kind of loss that might occur. Our goal is to create a technique based on sensors which will help in detecting the forest fires in the early stages. As soon as the fire is detected an alarm will be generated thereby minimizing the loss of environment, property or human life. The machine learning techniques integrated with the sensors help in detection of fire without any human help, therefore no patrolling is required. The advantage of sensors is that they are fast and accurate. The major disadvantage is the battery usage. We can overcome it by using the data collected in the next sensor if the previous one losses it's battery. Moreover, machine learning maximizes resource utilization and improvesthe performance of sensor networks.

We aim to evaluate the historical data and the natural events, predict the upcoming events based on acquired knowledge. Thus, the model will be capable of generating automatic warning signals whenever a dangerous situation arises, i.e., when fire or smoke is detected. Since this project is based on experimentation, it is constrained by many parameters. Primarily within the stipulated time, the correct response needs to be generated and provided to the user. One of the major issues is noise. Since weare depending on wireless sensors for our data, it is possible that this data might not be clean and may contain noise. Proper and quick preprocessing is required for optimal results. Another issue is accuracy. There is a huge possibility that a false positive response will be generated and a fake warning may be issued. By parameter optimization, we can reduce these false positives but not necessarily eliminate them. Also, the available computing power constraints the working of this system. The training and testing of models are compute-intensive tasks.

II. METHODOLOGY

This project requires training to be done before deploying. Using historical data, various machine learning techniques are applied for Model learning and validation. Accordingly, the model classifies the real-time data, pre- predicting the chances of fire.

A. Processing module:

The data acquired from sensors is sent to the pre-processing module. It performs thresholding, cleaning, transformation and any specific enhancements required for later employed algorithms.

B. Classification module:

Pre-processed data is then classified using machine learning algorithms using the classification module. The images are classified into with fire and without fire images. According to the result, alerting and alarming is done to the respective authorities.

C. User Interface module:

A user interface for monitoring and supervision purposes is provided. It shows real-time statistics and reports.

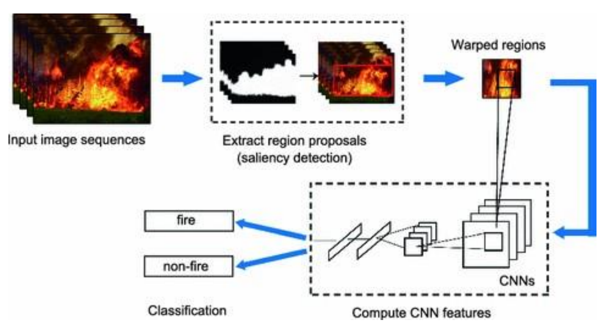
The Working phases are as follows:

D. Learning phase:

Using the historical data first we train the model using various machine learning algorithms. This involves training and validation and application of accuracy improvement techniques like bagging and boosting. Once the model is trained, it is exported and can be used for deployment purposes.

E. Testing phase:

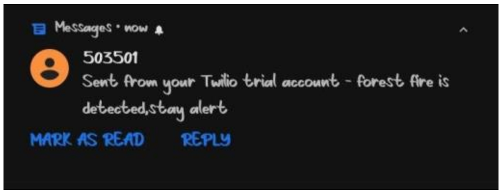
The system is exposed to the real-time data acquired either through cloud server or a local network. First, preprocessing is donein order to make the data suitable for algorithms to process. Cleaning is done to eliminate the noisy data followed by transformations and enhancements.

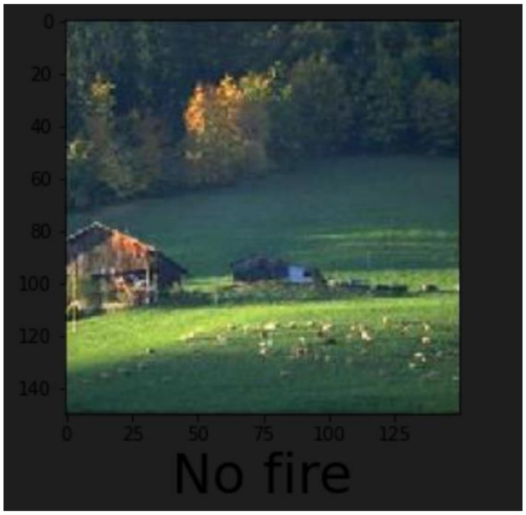


Then the data is subjected to machine learning algorithms which predict the chances of onset of fire. According to the prediction results, the concerned authorities are alerted and respectivemitigation measures can be taken to prevent or limit the damage.

III. RESULT

The implementation of the Tensorflow, keras, and open CV are done using the Google Collabnotebook. Google Collab notebook helps to write andexecute Python in the browser, where it is open- source and widely used for the implementation of machine learning algorithms such as regression, classification, and clustering.





The proposed model gives an accuracy of 96.49 and the video is analyzed and tested using the proposed model. When fire is detected a message willbe sent to the concerned mobile number.

IV. CONCLUSION

Efficiency and accuracy along with cost factor serve as key factors for the building of fire detection systems. In this project we understand the working of various machine learning techniques along with their advantages and limitations. According to evaluation factors appropriate choice can be made regarding the technique to be implemented. Also, a hybrid technique involving combination of algorithms can be suggested. Thispaper gives the idea about how combination of sensor data and prediction algorithms can be utilized to detect onset of fire and limit the damage caused to environment.

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