International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

FIRE DETECTION IN FOREST REGION USING CNN ALGORITHM

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Abstract : *The primary goal of this paper is the early detection of fire in the forest region. It detects the fire by extracting the images and videos in the camera. The research is primarily concerned with image recognition methods. This involves a series of steps, starting with the background subtraction because fire boundaries continuously changes. And then color segmentation model is used to mark the candidate regions. Finally, Convolutional Neural Network(CNN) is used for classifying the candidate regions has actual fire or non fire. Whenever actual fire incident happens it automatically detects the fire without any sensor device and sends sound alert to the forest department .*

Keyword *:Forest fire detection, Camera analysis, Image recognition ,Convolutional Neural Network, Machine learning.*

1.INTRODUCTION

Forest fires stand out as one of the most hazardous natural disasters globally. The rise in wildfire frequency and devastation can be attributed to various factors linked to global climate change, such as a longer average season, warmer weather, and earlier snowpack melting [1]. Unfortunately, a single forest fire can undo all the conservation and reforestation efforts made in recent years. Recent research by the Forest Survey of India (FSI) reveals that approximately 36% of the country's forests are susceptible to flames, with over 10% classified as highly hazardous [2].To effectively combat forest fires, public awareness and participation are crucial, alongside the implementation of scientifically-prepared forest fire management plans at the district and forest division levels. These management plans should employ various technological options for prevention, detection, early warning, firefighting, and damage assessment. Over the past few decades, numerous approaches have proven successful in forest fire management [3]. In this context, a proposed system employs a Convolutional Neural Network (CNN) to identify fire regions in the forest. It has multiple advantages, including automatic feature extraction, no need for human supervision[4]. The frequency of forest fire incidents in India has escalated by 52% in the last two decades, underscoring the importance of early fire detection in reducing fire losses. Early detection of fires with high sensitivity and accuracy is crucial for minimizing fire-related losses. The rapid advancements in digital cameras and video processing techniques have led to a notable shift towards using computer vision-based systems for traditional fire detection methods. Video-based fire detection techniques are particularly effective in identifying fires in large and open areas. With the widespread installation of surveillance systems indoors and outdoors, cameras are now utilized to detect fires.

The primary objective of the project is to minimize manual intervention by employing Convolutional Neural Network (CNN) based image recognition algorithms. These algorithms can efficiently learn and extract intricate image information automatically, achieving remarkable performance. The CNN demonstrates a high accuracy of 98% in detecting fire images. The system employs background subtraction to adapt to continuously changing fire boundaries and uses a color segmentation model to identify fire regions in the forest. In the event of a fire incident, the system promptly detects it and notifies the forest department using a sound alarm.

2.PROBLEM DESCRIPTION

The frequency and scale of intense forest fires are on the rise worldwide, with part of the blame being placed on the abandonment of traditional farmland. These forest fires have become a recurring and alarming issue, not confined to just the summer season[5]. The situation is exacerbated by the sixth generation of fires, known as mega forest fires, which are more aggressive and challenging to extinguish due to the effects of drought and global warming. Spain, for example, experienced over 65,000 hectares burned in the first half of 2023, accounting for 55% of all burned land in the European Union. It ranks highest in total area burned, followed by France, Romania, and Portugal.

To address these challenges, a fire detection technique has been developed to aid the forest department in early intervention[6]. In the past, smoke sensors were widely used for fire detection, but they required extensive training samples and could not always detect fires in forest regions, leading to devastating consequences. To address the problem of forest fires, a CNN (Convolutional Neural Network) algorithm is employed, which can detect fire in forest regions through image analysis, eliminating the need for traditional Sensor Devices and reducing manual intervention. This CNN algorithm offers higher accuracy compared to the SVM (Support Vector Machine) algorithm, which only detects image edges and tends to produce inaccurate results and consume more time[7]. When an actual fire occurs, the CNN algorithm triggers a sound alarm to alert the forest department. The research findings indicate that short-term image-based methods outperform traditional still image-based methods by reducing both false detections and misdetections. By adopting a machine learning-based fire detection approach, the reliance on time-consuming hand-crafted feature exploration is eliminated. This approach has proven to be effective in reducing false alarms and improving the accuracy of fire detection and rescue dispatch. The Convolutional neural network algorithm plays a significant role in achieving these results.

3.EXISTING SYSTEM

In existing system, smoke sensors are the widely used devices to detect fires. When the smoke sensors couldn't detect the fires in the forest region. It result in unbearable disaster. Smoke sensor need more training sample to detect actual fire. SVM (Support Vector Machine) algorithm only detects the image edges[8]. Which has inaccurate result and time consuming. This classification model achieves minimum accuracy of (68%). Support Vector Machine (SVM) is a supervised machine learning algorithm that can be used for classification and regression tasks[9]. The main idea behind SVM is to find the best boundary (or hyperplane) that separates the data into different classes.

The main drawbacks of SVM algorithm is not suitable for large data sets. SVM (Support vector machine) does not perform very well when the data set has more noise[10]. SVMs can be sensitive to the choice of parameters, and it can be difficult to determine the optimal parameter values for a given dataset. Support vector classifier works by putting data points, above and below the classifying hyperplane there is no probabilistic for the classification . Long training time for large datasets.

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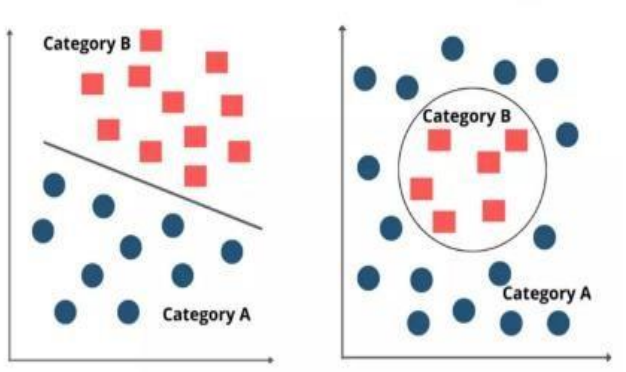
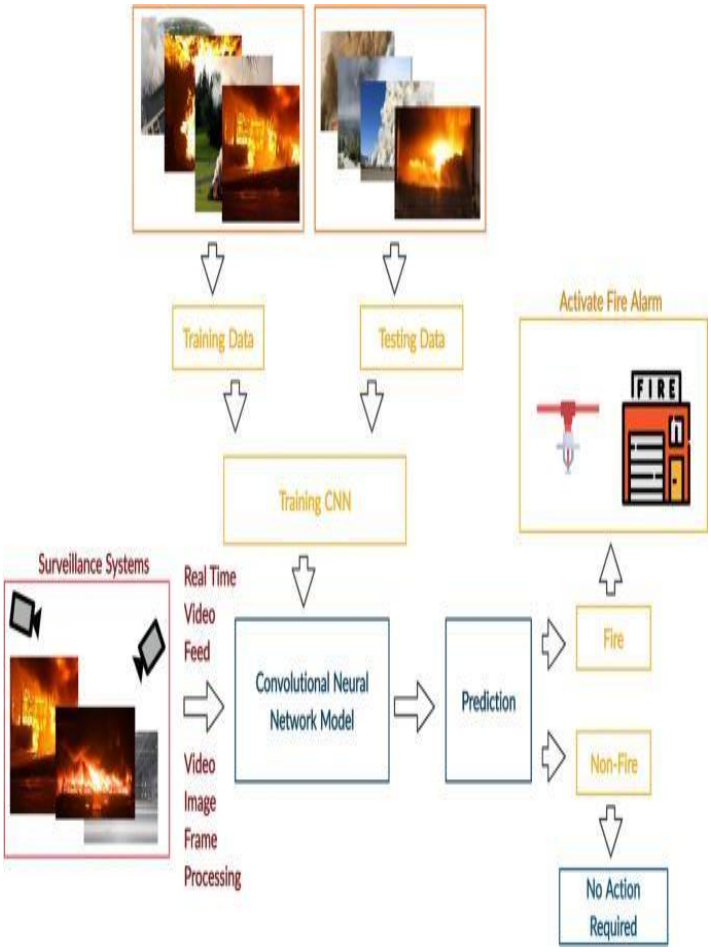


Support Vector Machine (SVM)

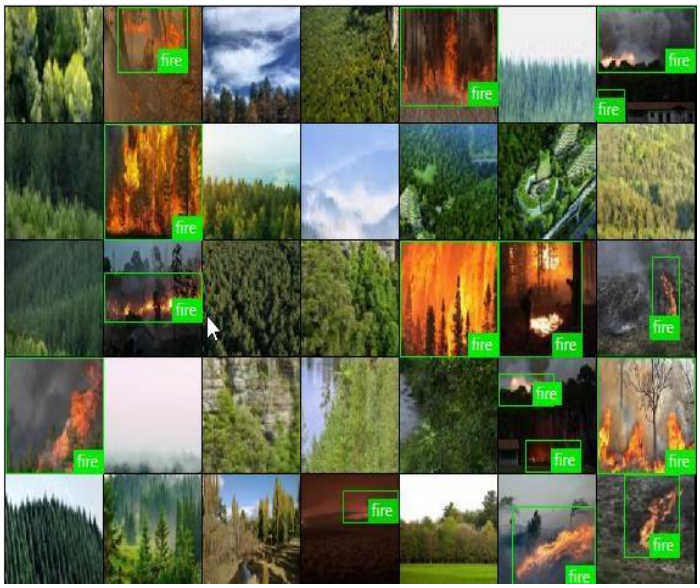


Convolution Neural Network(CNN)

3.1.PROPOSED SYSTEM

The proposed system can be used to overcome the problem faced in existing system. The proposed system is to provide a user-friendly project to detect the fire effectively without any Sensor Device and manual interaction. CNN (Convolutional neural network) algorithm is used to detect the fire in forest region. It has more accuracy(98%) to the image[11]. And minimize computation in comparison with a regular neural network. Finally, it is used to identify the fire regions and sends the sound alert intimation.

The major advantages for CNN algorithm are minimize computation in comparison with a regular neural network. No need to have lot of training dataset .It is easy to understand and fast to implement They are very accurate at image recognition and classification.



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4.METHODLOGY

Algorithm :

Step 1: Data collection compile a series of images and make sure the dataset is varied and reflects the situations the model .

Step 2: Data preprocessing get the dataset ready for training by preprocessing it.

Step 3: To divide the dataset,subsets for training, validation, and testing should be created from the dataset.

Step 4: Model Architecture creates the CNN architecture for fire detection. CNN consists of three convolutional layers they are activation functions, pooling layers, and fully linked layers.

Step 5: Model Compilation used to assemble the model before training, select an appropriate loss function and procedure.

Step 6: Use the training dataset to train the CNN. To reduce the selected loss function, the model's weights are changed iteratively.

Step 7: To enhance the performance of the model and avoid overfitting, fine-tune hyperparameters (learning rate and batch size) depending on validation findings.

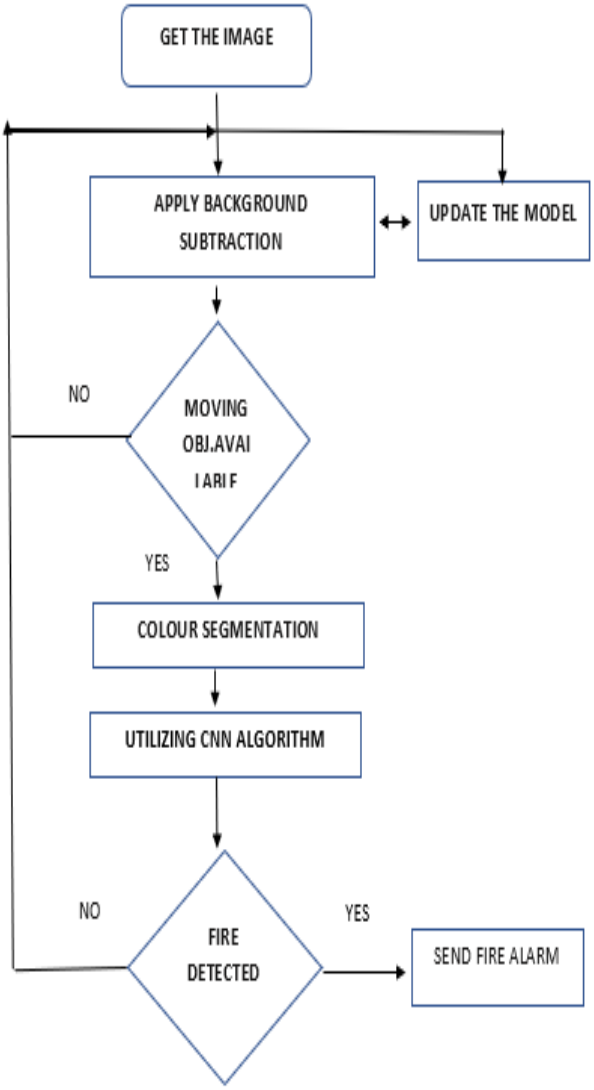
Step 8: The model's adaptability to new data is evaluated in through testing.

Step 9: Determine an acceptable threshold for the model's output (e.g., probability score) to categorize an image containing fire or not.

Step 10:Once the CNN model has been trained and tested, deploy it to the target environment.

Step11:Occasionally updating the model's training set helps to adjust the shifting circumstances and enhance its accuracy over time. Which helps to detect the fire and if fire incident happens it send the sound alarm to the forest department.

4.1 FLOW CHART



5.RESULT AND DISCUSSION

Before fire detection

In this research, the Automatic Fire Detection method is employed. Which uses image processing to identify fire accidents in the forest. This model works using CNN algorithm. It process the image and performs background subtraction and color segmentation to identify the fire region. Fire was detected with more accuracy rate using CNN algorithm. After detecting the fire in the forest region this system automatically sends the fire alarm to the forest department.

5.1. COPY OF OUTPUT

After fire detection

6.CONCLUSION

The implementation of advancement of object detection in CNN algorithm improved the efficiency of the fire detection. The aim of this work was to detect the fire region in forest and minimize the cost of damages. Detecting fire early and alerting the authorities helps the forest department to respond quickly. It detects the fire effectively in form of images, without any Sensor Device and human assistance, which is robust and works in any environment. CNN (Convolutional neural network) is used for classifying the regions of fire or non-fire in forest area. CNN learn and extract complex image features effectively[12]. If fire accident happens in forest, it detects the fire and intimates the forest department using sound alarm . Forest fire detection using CNN algorithms is a powerful and promising technique to improving early fire warning systems in forest areas[13]. The accurate and early detection of forest fires made possible by CNNs' capacity to learn complex patterns from visual input assists in reducing the disastrous effects of such occurrences on both the natural environment and human life. The present frameworks for fire detection can be intelligently adapted to identify fire. In daily life, this will make it possible for video surveillance systems to manage more complicated situations.

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