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Survey on Forest Wildfire Detection Using Deep Learning

Manasi Jadhav[1], Prof. Jitendra Musale[2], Omkar Kshirsagar[3], Anushri koli[4], Sarthak Shelke[5]

1Department of Computer Engineering, Savitribai Phule Pune university, pune
manasisjadhav1111@gmail.com,
2Department of Computer Engineering, Savitribai Phule Pune university, pune
jitendra.musale@abmspcoerpune.org
3Department of Computer Engineering, Savitribai Phule Pune university, pune
saikshirsagar10@gmail.com,
4Department of Computer Engineering, Savitribai Phule Pune university, pune
anushri.k2105@gmail.com,
5Department of Computer Engineering, Savitribai Phule Pune University, pune
shelkesarthak20@gmail.com

Abstract—***The advent of satellite technology has made it possible to continuously monitor and manage forest fires, which pose a serious hazard to people and other living things. Smoke in the air indicates the presence of forest wildfires. Fire detection is essential in fire alarm systems for preventing damage and other fire catastrophes that have an impact on society.***

It's crucial to effectively identify fire from visual settings to prevent large-scale fires. An efficient method of a convolutional neural network based Inception-v3 based on transfer learning is developed to increase the accuracy of fire detection. It trains satellite images to classify datasets into fire and non-fire images, generates a confusion matrix to determine the framework's effectiveness, and then uses local binary patterns to extract the fire-occurring region from satellite images. This method lowers the rate of false detection.

Keywords–:: Convolutional Neural Network (CNN), deep learning, Inception-v3, fire detection, image classification.

I. INTRODUCTION

In the world, forest fire poses serious risks to the survival of people, animals, and flora. Fast response and a vast detection area are ineffective for detecting fire when using standard approaches. Fire can make major hazards in this hectic world. It is very harmful when a fire occurs in a forest. But most of the time, the detection of forest fire happens when it spread over a wide region. Sometimes, it could not be possible to stop the fire. As a result, the damage of the environment is higher than predictable. The emission of large amount of carbon dioxide (CO2) from the forest fire damages the environment. As well as it would lead to complete disappearance of rare species in the world .The forest is a large surface of area filled with trees, lots of dried leaves, woods and so on. These elements encourage the fire when it starts. The fire can be ignited through many reasons such as high temperature in summer seasons, smoking, or some parties which having fireworks. Once fire starts, it will remain until it distinguished completely. The damage and the cost for distinguish fire because of forest fire can be reduced when the fire detected early as possible. So, the fire detection is important

in this scenario. Finding of the exact location of the fire and sending notification to the fire authorities soon after the occurrence of fire can make a positive impact. There are different types of fire detection methods used by the Government authorities such as satellite monitoring, tower monitoring, using sensors, optical cameras and so on. There are some other techniques used for fire suppression. The major one is burning the dry areas or like in Canada; they are using flying water tanks for fire suppression. In middle east countries, these elements sweep away and burnt it in a certain unfuelled place. But, in Australia, they provide fire in these areas and wait until it dies itself without make any danger to the wildlife or humans.

A research study shows an automatic fire detection can be divided into three groups: aerial, ground and borne detection. The ground-based systems use several staring black and white video cameras are used in fire detection which detect the smoke and compares it with the natural smoke.. In woods, wildfires are an unavoidable risk that can create disasters. Nearly 85% of the world's trees are being lost each year by forest fires, which causes catastrophic climate shifts and global warming. Forest fires are categorised based on their size, texture, and rate of movement. Lighting, volcanic eruptions, spontaneous combustion of dry plants, smoking close to flora, and farmers intentionally setting fire to their fields are all examples of man-made or natural fire, respectively.

II. EXISTING SYSTEM

The advent of satellite technology has made it possible to continuously monitor and manage forest fires, which pose a serious hazard to people and other living things. Smoke in the air indicates the presence of forest wildfires. Fire detection is essential in fire alarm systems for preventing damage and other fire catastrophes that have an impact on society.

As a result of both natural and man-made climatic changes, forest fires have become a severe problem. A smart city application that uses a forest fire detection technology based on artificial intelligence is provided in order to prevent big disasters.

Disadvantages of Existing System

1.There are many existing systems available in the world for fire detection but all of them uses number of ways instead of alarm system. Which can be very hectic as you must see the disaster of the environment .

2. All the existing systems uses different techniques which are easy to classify but is hard to implement for detection of fire forest.

Proposed System Advantages

The advent of satellite technology has made it possible to continuously monitor and manage forest fires, which pose a serious hazard to people and other living things. Smoke in the air indicates the presence of forest wildfires. Fire detection is essential in fire alarm systems for preventing damage and other fire catastrophes that have an impact on society.

Advantages Of Proposed System

1. Accurate, Robust, reliable, affordable.
2. No need of setting of dedicated infrastructure.
3. Minimized use of computing resources.

III.RELATED WORK

Martin Maier, MahfuzulhoqChowdhury, Bhaskar Prasad Rimal, and Dung Pham Van-This essay initially elaborates on the similarities and minute distinctions between the Tactile Internet, the Internet of Things, and the 5G vision in order to help readers comprehend it better. We first briefly discuss the expected impact on society and the necessary infrastructure, and then we present a current overview of recent advancements and supporting technologies suggested for the Tactile Internet. Given that expanding research in the area of wired and wireless access networks in the future will be necessary for the Tactile Internet

Yaqin Zhao, Qiujie Li, ZhouGu- The study findings in the film about the forest fire serve as inspiration for a revolutionary smoke detection technique that uses CS Adaboost. On the one hand, the movement direction of a potential smoke block is utilised to define the flutter characteristic of the smoke video,

which is used to differentiate between smoke and dense fog. The CS Adaboost algorithm, on the other hand, is offered as a smoke classifier of forest fire to effectively and efficiently recognise early smoke of forest fire..

Sebastien Frizzi1 RabebKaabiMoez, Bouchouicha, Jean-Marc Ginoux, Eric Moreau, FarhatFnaiech- This paper We suggest using a CNN (convolutional neural network) to detect fire in videos. It has been demonstrated that convolutional neural networks excel at object classification. Within the same architecture, this network has the capacity to carry out feature extraction and categorization. Tested on actual video sequences, the suggested method outperforms certain pertinent traditional video fire detection techniques in classification performance, showing great promise for CNN-based video fire detection.

OleksiiMaksymiv, TarasRak ,DmytroPeleshko-This study provides a revolutionary cascaded-based method for processing camera monitoring data to identify specific sorts of emergencies, such as fire, smoke, and explosions. First, for obtaining the Region of Interest (ROI) and lowering time complexity, the Adaboost and Local Binary Pattern (LBP) combination is utilised. Next, we suggest using a convolutional neural network to address typical vulnerabilities like false positives (CNN). The final experimental findings demonstrated that this method's accuracy rate for detecting crises may reach 95.2%.

KHAN MUHAMMAD1, IEEE), JAMIL AHMAD1 , IRFAN MEHMOOD2, SEUNGMIN RHO3, SUNG WOOK BAIK- In this study, we suggest a CNN architecture for surveillance movies that can efficiently identify fire. Given its fair computing complexity and inspiration from Google Net architecture, in comparison to other computationally expensive networks like "AlexNet," appropriateness for the target problem. The model is adjusted taking into account the nature of the target problem and fire data in order to strike a compromise between efficiency and accuracy.

Rabeb Kaabi1, MounirSayadi,MoezBouchouicha,FarhatFnaiech, Eric Moreau-In this paper, a novel machine learning-based method for smoke detection to combat forest wildfires is presented (Deep Belief Network). Many security and surveillance applications use video smoke detection. To have a powerful smoke detector, a smoke detection system should have a high detection rate. The method we employed for smoke detection is called Deep Belief Network, which is a stacked layer of Restricted Boltzman Machine. This method concurrently extracts and classifies regions with and without smoke. After measuring the smoke detection rate, pre-trading time, and fine-tuning time, the effectiveness of our applied smoke detection technique is assessed..

Khan Muhammad, Jamil Ahmad, ZhihanLv , Paolo Bellavista , Po Yang , and Sung WookBaik ,-In this paper, For fire detection, localization, and semantic understanding of the fire scenario, we suggest a novel, environmentally responsible, and computationally efficient CNN design that is inspired by the Squeeze Net architecture. It keeps the processing needs to a minimum by using smaller convolutional kernels and excluding dense, fully linked layers. The experimental results show that, despite its modest processing requirements, our suggested approach reaches accuracy levels that are comparable to those of other, more sophisticated models, largely because of its greater depth.

Daniel Y. T. Chino, Letricia P. S. Avalhais, Jose F. Rodrigues Jr., Agma J. M. Traina–In this paper, We introduced the BoWFire method, a cutting-edge way for detecting fire on photos in an emergency situation. Our findings demonstrated that BoWFire could detect fire with performance comparable to that seen in state-of-the-art works, but with fewer false positives. We rigorously compared our work to four earlier papers to show that we made steady progress.

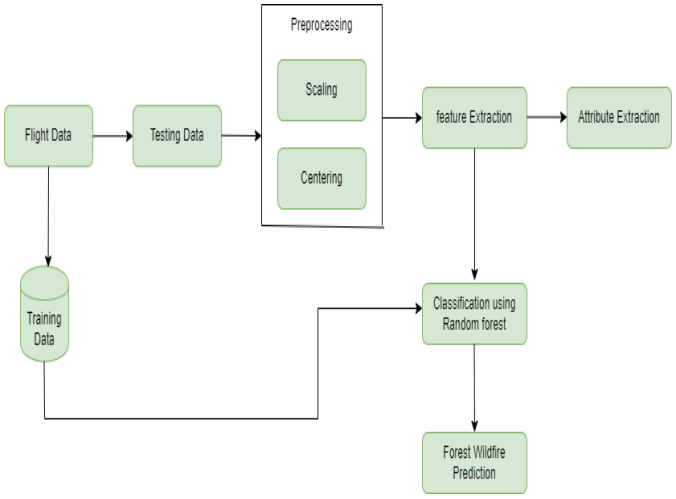
JiviteshSharma(B) , Ole-ChristofferGranmo, Morten Goodwin, and Jahn Thomas Fidje-It turns out that when tested on the more realistically balanced benchmark dataset presented in this research, a standard CNN performs relatively poorly. In order to better detect fire in images, we suggest using even deeper convolutional neural networks and fine-tuning them using a fully connected layer. We use two pretrained state-of-

the-art Deep CNNs, VGG16to create our fire detection system, along with Resnet50. Those Deep CNNs
tested on our skewed dataset that we've put together to replicatereal-world examples

Shixiao Wu, Libing Zhang–In this paper,We concentrate on three issues related to real-time, early, and false fire detection in forest fires. We employ traditional objective detection techniques for the first time, including faster R-CNN, YOLO (tiny-yolo-voc, tiny-yolo-voc1, yolo-voc.2.0, and yolov3), and SSD. The real-time performance, detection accuracy, and ability to detect fires early are all improved by SSD. To reduce incorrect detection, we create a fire and smoke benchmark, use the newly introduced smoke class, and modify the fire area. In the meantime, we modify the tiny-yolo-voc structure of YOLO and suggest a new structure. The results show that this increases the rate of fire detection accuracy, tiny-yolo-voc1.

IV. SYSTEM ARCHITECTURE

A system architecture is the conceptional model that defines the structure, behaviour, and more views of a system. An architecture description is a formal description and representation of a system, organized in the way that supports reasoning about the structures and behaviour of the system.



V. MODEL METHODOLOGY

- In the world, forest fire poses serious risks to the survival of people, animals, and flora.
- Fast response and a vast detection area are ineffective for detecting fire when using standard approaches.
- In general, the forest serves as a haven for a wide variety of resources, as well as regulating CO2 emissions and having a complex ecosystem.
- In woods, wildfires are an unavoidable risk that can create disasters. Nearly 85% of the world's trees are being lost each year by forest fires, which causes catastrophic climate shifts and global warming.
- Forest fires are categorised based on their size, texture, and rate of movement.
- Lighting, volcanic eruptions, spontaneous combustion of dry plants, smoking close to flora, and farmers

intentionally setting fire to their fields are all examples of man-made or natural fire, respectively.

VI. ALGORITHM

The algorithm used here is Random Forest. Random Forest is the most popular and powerful algorithm of machine learning.

- Step 1: Assume N as number of training samples and M as number of variables within the classifier.
- Step 2: The number m as input variables to decide the decision at each node of the tree; m should be much less than M.
- Step 3: Consider training set by picking n times with replacement from all N available training samples. Use the remaining of the cases to estimate the error of the tree, by forecasting their classes.
- Step 4: Randomly select m variables for each node on which to base the choice at that node. Evaluate the best split based on these m variables in the training set.
- Step 5: Each tree is fully grown and not pruned (as may be done in constructing a normal tree classifier).For forecasting, a new sample is pushed down the tree. It is assigned the label of the training sample in the terminal node it ends up in. This procedure is repeated over all trees in the ensemble, and the average vote of all trees is reported as random forest prediction. i.e. classifier having most votes.

VII. MATHEMATICAL MODEL

S = {I, F, O}

Where, I = Set of Inputs

It uses forest dataset.

F = Set of functions

F = {F1, F2, F3....FN}

F1: Data Extraction

F2: Pre-processing

F3: Feature Extraction

F4: Classification

O: Wildfire Detection

Conclusion

For fire detection and classification methods, features are manually retrieved from input photos using traditional and hand-crafted algorithms, and then a sophisticated classifier is trained to categorise the images. Both methods' performance degrades in terms of speed, particularly for the larger image dataset. Inception-v3 has the ability to automatically extract features; analysis and experimental data show that this architecture achieves high detection rates.

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