FOREST FIRE CLASSIFICATION

Problem Statement

Design a computer vision system to automatically detect and classify forest fires in images or videos captured by surveillance cameras in forested regions. The system should accurately identify whether a given image or frame:

1. **Contains no fire**: The scene is normal, with no signs of fire.

2. **Contains fire**: Flames or smoke are present in the scene, indicating a potential forest fire.

Introduction

Forest fires pose significant threats to ecosystems, biodiversity, and human lives. Early detection and accurate classification of forest fires are crucial for timely intervention and effective management of fire incidents. Traditional methods of forest fire detection rely on human observation, satellite monitoring, or ground-based sensor networks, which may have limitations in terms of coverage, reliability, and response time. Computer vision-based approaches offer promising solutions to enhance the efficiency and effectiveness of forest fire detection and classification.

Topic one

List Of Research Labs Working In Forest Fire classification.

Research Labs

1. **Forest Advanced Computing and Artificial Intelligence (FACAI) Lab - University of Alberta, Canada:**
    1. Website: FACAI Lab
2. **Forest Fire Remote Sensing and GIS Lab - University of Maryland, USA:**
    1. Website: Forest Fire Remote Sensing and GIS Lab
3. **Centre for Fire, Explosive and Environment Safety (CFEES) - DRDO, India:**
    1. Website: CFEES
4. **Remote Sensing Lab - University of Valladolid, Spain:**
    1. Website: Remote Sensing Lab
5. **Remote Sensing Research Centre - University of Queensland, Australia:**
    1. Website: Remote Sensing Research Centre
6. **Centre for Integrated Remote Sensing and Forecasting for Arctic Operations (CIRFA) - UiT The Arctic University of Norway:**
    1. Website: CIRFA
7. **Laboratory of Remote Sensing and GIS (LRSG) - University of Tehran, Iran:**
    1. Website: LRSG
8. **Wildland Fire Sciences Lab - USDA Forest Service, USA:**
    1. Website: Wildland Fire Sciences Lab
9. **Center for Wildland Urban Interface Research & Design (WISeR) - Auburn University, USA:**
    1. Website: WISeR
10. **Fire Research Laboratory - National Institute of Standards and Technology (NIST), USA:**
    1. Website: Fire Research Laboratory

Topic Two

Products Developed

Products Developed

1. **MODIS (Moderate Resolution Imaging Spectroradiometer) Fire Detection System:**
    1. Developed by NASA, the MODIS Fire Detection System utilizes satellite imagery to detect active fires and monitor fire activity globally. It provides near-real-time fire detection and monitoring capabilities, aiding in the management and response to forest fires.
2. **VIIRS (Visible Infrared Imaging Radiometer Suite) Fire Detection System:**
    1. Similar to MODIS, VIIRS is a satellite-based system developed by NASA and NOAA. It detects fires by observing changes in thermal radiation and provides data on fire location, size, and intensity.
3. **Sentinel-2 Satellite:**
    1. The European Space Agency's Sentinel-2 satellite mission provides high-resolution optical imagery that can be used for forest fire monitoring and classification. The data from Sentinel-2 satellites are freely available and have been utilized in various research projects and operational systems.
4. **Fire Weather Index Systems:**
    1. Various organizations and agencies have developed fire weather index systems, such as the Canadian Forest Fire Danger Rating System (CFFDRS) and the Australian Forest Fire Danger Rating System (AFFDRS). These systems use meteorological data to assess fire risk and help in fire prevention and management.
5. **Computer Vision-Based Fire Detection Systems:**
    1. Several companies and research groups have developed computer vision algorithms for detecting fires in images and videos captured by surveillance cameras. These systems use deep learning techniques, such as convolutional neural networks (CNNs), to automatically identify flames and smoke in real-time.
6. **Ground-Based Sensor Networks:**
    1. Some companies and research institutions have developed ground-based sensor networks equipped with temperature, humidity, and smoke sensors to monitor forest fire conditions in real-time. These networks can provide early warnings and help in the rapid deployment of firefighting resources.

Topic Three

Dataset Details

Dataset details

There are total of 755 images where the forest is caught under fire and 244 images where it was normal
dataset totally contains 999 images

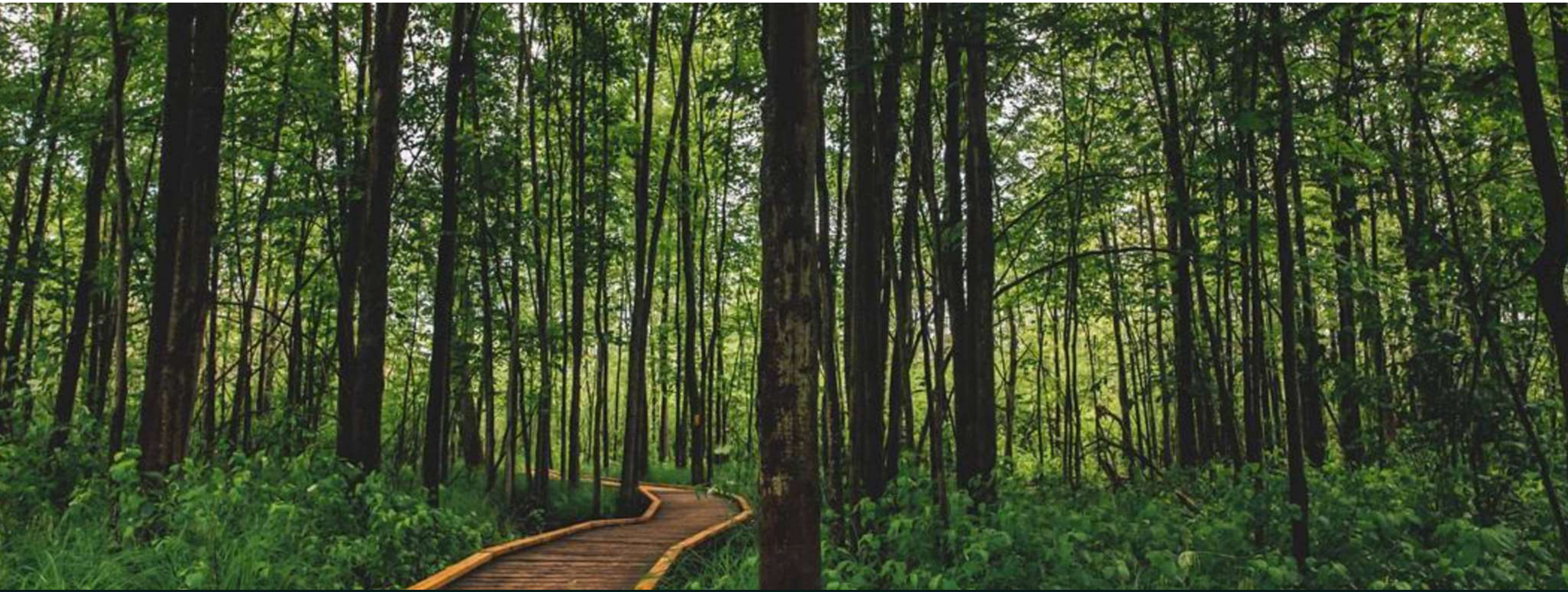
The Images are been collected from the Kaggle website

Topic Four

Literature Survey

Research	Method	Dataset Type	Classes	Accuracy	Precision	Recall	TNR	FPR	FNR	F1
Lee et al. [25]	AlexNet VGG13 Modified VGG13 GoogleNet Modified GoogleNet	Image	fire and non-fire	94.8% 86.2% 96.2% 99.0% 96.9%	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
Kaabi et al. [26]	DBN	Images through video	smoke and no smoke	95%	-	-	-	-	-	-
Zhao et al. [27]	Fire_Net	Image	fire and no-fire	98%	-	98.8%	97.2%	-	0.12%	-
Chen et al. [28]	CNN-9 CNN-17	Images through video	smoke and flame	61% 86%	- -	80% 98%	- -	72% 34%	- -	- -
Cao et al. [29]	Abi-LSTM	Images through video	smoke and non-smoke	97.8%	-	97.5%	98%	-	-	-
Sousa et al. [30]	Inceptionv3	Image	fire and not fire	93.6%	94.1%	93.1%	94.1%	-	-	-
Govil et al. [31]	Inceptionv3	Image	smoke and non-smoke	91%	-	-	-	-	-	89%
Tang et al. [32]	ForestResNet	Image	normal, smoke and fire	92%	-	-	-	-	-	-
Park et al. [33]	VGG16 ResNet50 Densenet121	Image	wildfire, non-fire, flame, smoke, building and pedestrian	- - -	96.4% 96.6% 99.1%	95.6% 94.9% 97.8%	- - -	- - -	- - -	96% 95.6% 98.5%
Sun et al. [34]	CNN_S	Image	fire and without fire	94.1%	-	-	-	-	-	-
Khan et al. [35]	VGG19	Image	fire and no-fire	95.0%	95.7%	94.2%	95.8%	4.2%	5.8%	94.9%

Literature Review



Topic Five

Detection

Detection

1. **Image Preprocessing**: Prior to feeding images into CNN models, preprocessing techniques such as resizing, normalization, and enhancement may be applied to improve the quality of input images and reduce noise.

2. **Feature Extraction**: CNNs automatically learn hierarchical representations of features from input images. In the context of forest fire detection, features related to flames, smoke, heat patterns, and contextual information (e.g., forest vegetation, terrain) are learned by the network.

3. **Training Data Collection**: Datasets containing labeled images of forests with and without fires are collected. These datasets are used to train CNN models to recognize patterns associated with fire, smoke, and other relevant features.

4. **CNN Architecture Design**: Various CNN architectures, such as VGG, ResNet, and custom-designed networks, can be utilized for forest fire classification. These architectures may consist of multiple convolutional layers followed by pooling layers, fully connected layers, and activation functions.

5. **Model Training**: The CNN model is trained on the collected dataset using supervised learning techniques. During training, the model learns to classify images as either containing a fire or not.

Topic Six

Tracking.

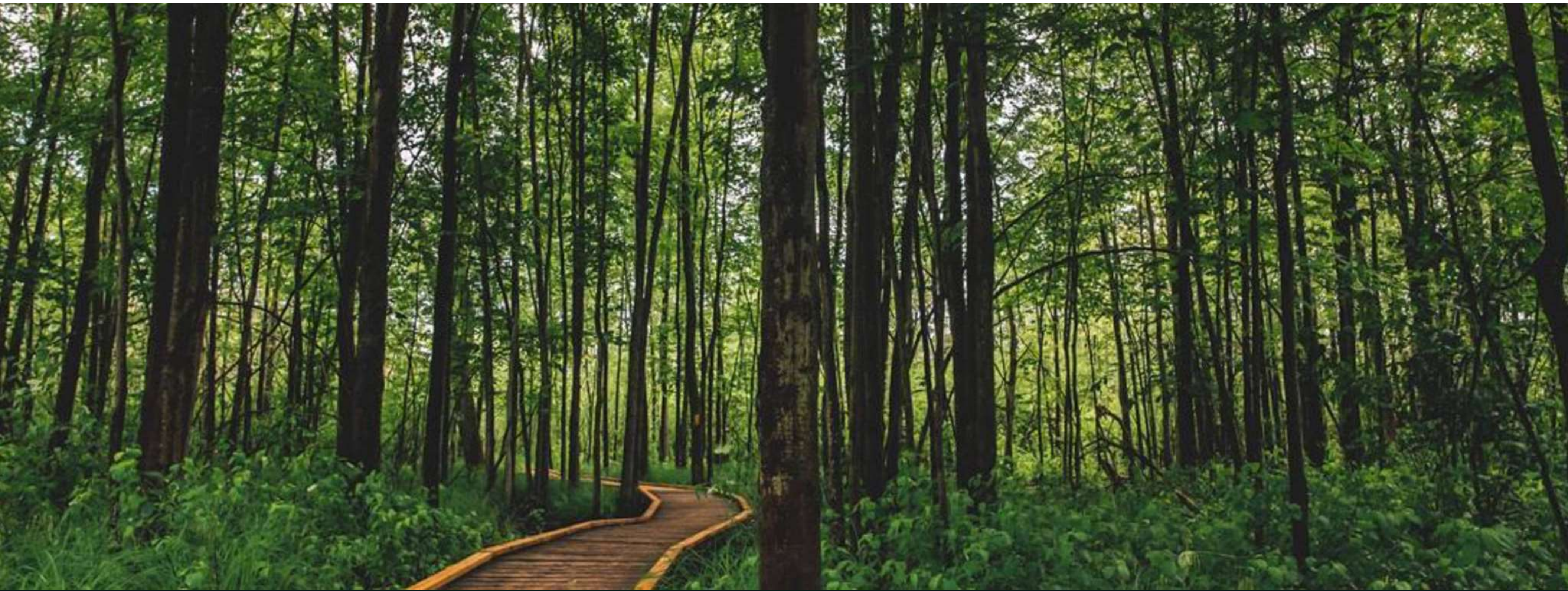
Tracking

In a project focused on forest fire classification using computer vision and CNNs, the emphasis may not be on real-time tracking of fire propagation but rather on detecting and classifying the presence of fire in static images or video frames. However, if the project includes tracking fire movement or other dynamic phenomena related to fires, tracking algorithms may still be relevant. Here are some tracking algorithms that could be used in such a project:

1. **Optical Flow**: Optical flow algorithms can estimate the motion of pixels between consecutive frames in a video sequence. While primarily used for motion estimation, optical flow can indirectly aid in tracking fire movement or smoke propagation in video footage.

2. **Mean Shift Tracking**: Mean Shift is an iterative algorithm used for locating the modes of a probability density function. It can be adapted for tracking the movement of fire or smoke regions in video frames or sequences.

3. **Particle Filtering**: Particle filtering, also known as Sequential Monte Carlo methods, is a probabilistic approach to tracking objects over time. It can be used to track the movement of fire fronts or smoke plumes in video data.



Topic Matching

Matching

Matching And possible filters

Histogram-based Matching:

1. **Histogram Comparison**: Histogram-based methods compare the histograms of images or image regions to quantify their similarity. Techniques include Histogram Intersection, Chi-Square Distance, and Bhattacharyya Distance.

1.**Possible Filters**:

1. **Smoothing Filters**: Gaussian blur, median filter, bilateral filter.
2. **Edge Detection Filters**: Sobel, Prewitt, Canny.
3. **Sharpening Filters**: Laplacian, unsharp mask.
4. **Noise Reduction Filters**: Wiener filter, median filter, Gaussian filter.
5. **Color Enhancement Filters**: Histogram equalization, gamma correction.

2.**RGB to CMYK Color Model**:

1. RGB (Red, Green, Blue) and CMYK (Cyan, Magenta, Yellow, Key/Black) are different color models used in digital imaging.
2. RGB is an additive color model used in displays where colors are created by combining red, green, and blue light.
3. CMYK is a subtractive color model used in printing where colors are created by subtracting cyan, magenta, yellow, and black ink from a white background.
4. Converting between RGB and CMYK color spaces involves specific mathematical transformations to represent colors accurately for display or printing purposes.

3.**Key Frames in Images**:

1. Key frames are representative frames selected from a sequence of video frames.
2. In the context of video processing, key frames are typically chosen to minimize redundancy and reduce storage or transmission bandwidth.
3. Key frames often represent significant changes or transitions in the video content.
4. Key frame selection algorithms consider factors such as scene changes, motion, and visual content similarity to identify frames that best represent the overall video sequence.

4.**Relevant Frames in Data**:

1. In the context of data analysis or machine learning, relevant frames refer to data points or instances that are significant for a particular task or analysis.
2. Relevant frames can include key data points, outliers, or representative samples that capture important features or patterns in the dataset.
3. Identifying relevant frames may involve exploratory data analysis, feature selection techniques, or domain-specific knowledge to determine which frames are most informative for the analysis.

Team

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Thank you