Literature Survey On Emerging Methods For Early Detection Of Forest Fires

Abstract:

Over the last few decades, forest fires are increased due to deforestation and global warming. Many trees and animals in the forest are affected by forest fires. Technology can be efficiently utilized to solve this problem. Forest fire detection is inevitable for forest fire management. The purpose of this work is to propose deep learning techniques to predict forest fires, which would be cost-effective. The mixed learning technique is composed of YOLOv4 tiny and LiDAR techniques. Unmanned aerial vehicles (UAVs) are promising options to patrol the forest by making them fly over the region. The proposed model deployed on an onboard UAV has achieved 1.24 seconds of classification time with an accuracy of 91% and an F1 score of 0.91. The onboard CPU is able to make a 3D model of the forest fire region and can transmit the data in real time to the ground station. The proposed model is trained on both dense and rainforests in detecting and predicting the chances of fire. The proposed model outperforms the traditional methods such as Bayesian classifiers, random forest, and support vector machines.

Introduction:

Wildfires are a significant hazard to ecological systems around the world and pose a serious threat to human safety. People visually look for signs of fire or smoke appearance to detect fire in older days. To detect fire at early stage we use smoke which is the good indicator of fire which is visible before flames. Characteristics of smoke need to be considered such as transparency, its response to environmental condition, its shape. In open environment smoke detection pose a serious challenge in such areas sensors may be used but this has limitations such as time and wide area coverage. To overcome this video fire detection systems are used. Different image processing techniques can be used to detect fire and smoke. In image processing image or video is taken as input and the output may either an image or parameters or characteristics of an image. Various tasks like analysis classification, extracting the features, recognizing different patterns can be performed using image processing. The features and textures of smoke can extract using various image processing techniques. By using these techniques the dangerous situations caused due to fire can be avoided and safety of the people can be preserved.

Related Works:

Detection of forest fire and smoke in wildland areas is done through remote sensing-based methods such as satellites, high-resolution static cameras fixed on the ground, and unmanned aerial vehicles (UAVs).

The limitations of the satellites are described as follows:

i. Images that are captured through the satellites have poor resolution, and hence, it becomes difficult to detect the particular area
ii. Continuous information about the status of the forest could not be obtained due to the restrictions in the monitoring of forests
iii. Weather might not be stable in all situations as it might vary, and thus, it results in the collection of noisy images

Optical/thermal cameras deployed on the observation towers together with the other sensors such as smoke, temperature, and humidity sensors might detect the hazards in the closed environment rather than in the open environment as these sensors need vicinity to the fire or smoke. The information obtained through these sensors is not appropriate. Distance covered by these methods could be limited, and to cover a large area, more sensors have to be deployed that might incur expenses. Through the deployment of UAV, large areas could be covered, and the images with high spatial and temporal resolutions could be captured properly. The operational cost is very low when compared with the other methods.
In , detection of forest fire is done through the deployment of YOLOv4 to UAV-based aerial images. The initial phase of the process is that the authors developed the hardware platform and proposed the YOLOv4 algorithm. Frame detection rate through this method obtained is 3.2 fps, and the recognition rate achieved is 83%. This works when the intensity of the fire is huge. The limitation of this algorithm is that the detection rate is very less in the small fire-spot areas. The authors have made use of

the NetImage classifier that has the combination of Yolov5 and EfficientDet. The data set used comprises 10,581 images of which 2,976 images are categorized as forest fire and 7,605 as nonfire images. The model undergoes an adequate training process, and an accuracy of 99.6% has been obtained with the 476 fire images, and for 676 images that looked similar to images that display fire, the accuracy achieved was 99.7%. Yet the limitation is that it does not detect the smoke since it is needed in the initial stage of the detection process.
In this work the detection of forest fire is done automatically with the help the image processing methods. The principle behind the proposed work is that the image brightness and motion clues are used with the image processing techniques that depend on histogram-based segmentation. Initially, the hot objects are identified, and they are recognized as the candidate regions. Next, the motion vectors of the candidate regions are computed based on the optical flow. Furthermore, the vectors are used to isolate the fires from the other systems that might look similar to the fire. Tracking of fire from IR images is done through the Blob counter technique and morphological operations

i. An efficient and robust 3D modeling is used to augment the accuracy of the detection.

A deep learning technique YOLOv4 is combined with the Otsu method along with LiDAR. The key objective of utilizing the Otsu method is to repeat all the values of the threshold and evaluate the extent of the background and foreground pixels. The objective is to determine the threshold by examining the region of the spread, and it should be minimum.

ii. Traditional methodologies are found to be difficult for performing the sampling since the constraints are bound to the relative position. Hence, the orientation of the images is required, and that is obtained by computing the distance between the tree and other entities with the help of LiDAR.describes the proposed methodology.

Proposed Methodology:

The flow of the proposed architecture is show is The video input is captured from the camera, and the other inputs such as wind speed, wind directions, and IR image sensing are calculated using the sensors mounted on the UAV for navigation. These images are provided as input to the deep learning models, and it checks for the existence of the fire. The region is predicted clearly since there is a possibility of more projections of the images provided to the model due to the 3D modeling. Further detection is made, and the details are stored in the database for further.

Autonomous Drone Routing:

Drone Moment to the Target

In this whole operation, navigation of UAVs is significant to patrol the risk-prone areas and fire-detected areas. This work monitors the forest area with the help of the navigational analysis technique. To facilitate this, the drone makes the navigation. UAVs have the following three navigational features

i.Awareness: This provides details about UAV's neighborhood obstacles. The data is collected using internal sensors

ii.Basic Navigation: Collisions are avoided, and the obstacles such as birds, trees, poles, and so on in the forest farms are detected

iii.Expanded Navigation: Advanced features such as pathway planning and depth deployment are included and play a crucial role in autonomous navigation.

Conclusion and Future Scope:

Evolution emerges in the processing, computation, and algorithms. This strives many researchers to pay attention in many domains where they work in the processing of surveillance video streams so that abnormal or unusual actions could be detected. The usage of UAVs is recommended in the detection of forest fire due to the high mobility and ensures the coverage areas at various altitudes and locations at a low cost. Hence, an efficient and scalable UAV is used for detection. This work aims in developing the 3D model for the captured scene. YOLOv4 tiny network is deployed to detect the fire. The accuracy of the detection rate achieved through this model is 91%. The proposed model outperforms the other existing techniques in terms of detecting in the early stage. However, this model is sensitive to the forest with dense fogs and clouds. This is because smoke appears as the same as fog, and the model may misclassify the fog as smoke. As our future works, focus to meet practical detection and meet the necessity of early detection including the generation of the mixed reality model of the forest fire area that gives more information, and prevention analysis will be made easy. The 3D modeling techniques presented in this paper can also be extended to various natural disaster prediction models.