Forest Fire Detection Using YOLO V7

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Abstract- *One of the most challenging environmental crises faced by humans is forest fires. There is a notable increase in forest fires nowadays. Thanks to the technology for creating fast sensors, however, in case of forest fires the risk of failure in accuracy and false alarm rate are major setbacks that need to be resolved. In this paper a technique is proposed on the basis of vision based fire analysis in the segmentation of fire pixels. The proposed technique combines Yolov7 for forest fire detection. A dataset of forest fire images and normal fire object like images are used for training and testing purposes. Numerous Machine Learning models also have been implemented in this because of their great capability in determining, detecting and identifying objects. The earlier proposed systems there were various limitations. Throughout the years these limitations were noticed by more than one researcher and every researcher who tried to work in this domain have tried to overcome these limitations by implementing new techniques and giving better results.*

Keywords- Forest Fires, Fire detection, Fire segmentation, Machine Learning, YOLOv7

I. INTRODUCTION

Forest fires when not attended to and not contained tend to cause a lot of the damage to the areas of vegetation. Forest fires are very dangerous. Forest fires can be both man-made or they can occur naturally. Forest fires are a common occurrence that is often seen in the summer. According to estimates, more than 36% of the nation's forestland is vulnerable to frequent forest fires. According to ISFR (India State of Forest Report) 2019, 6% of the country's forest cover is assessed fire prone, compared to about 4% of forest cover that is extremely fire prone. Every year, fires of various sizes and intensity spread across wide areas of woodlands. According to records from the forest inventory, 35.71% of India's forests have not yet experienced any significant fires, while the remaining 54.45% of forests are occasionally exposed to fires, 7.49% are moderately frequently exposed to fires, and 2.40% are very frequently exposed to fires. Forest fires that occur when they are unpredicted usually occur a lot of damage when compared to the forest fires that were predicted before it. To avoid these dangerous disasters, systems for detecting and monitoring forest fires at the early stages are very crucial. The earliest fire detection systems used various sensors such as smoke detectors, gas detectors, flame sensors and temperature detectors but these techniques are not efficient in the case of detecting forest fires in wild lands. These detection techniques have smaller detection areas. In the future generations' Machine Learning techniques were implemented to improve the reliability of forest fire detection systems. Neural Networks were also introduced in this domain. Deep Learning (DL) approaches were also followed to improve the detection and localization of the fire that needed to be predicted in the forest. These techniques helped a lot to retrieve relevant features that could represent the best way that a fire can be described. Forest fire early detection with different features of forests and fires helps to eradicate the forest fire at the earliest and it does not cause the heavy damage to the forest land and to the habitat. To indicate the forest fire in advance to control the fire before it destroys most of the land is the vital task for the firefighters and the forestry department. The forest fire detection and prediction include various factors, for example environment and climatic conditions, atmospheric temperature, atmospheric pressure, dryness of the leaves and Peet, wind speed in the region, distance from the agricultural lands and roads, lightning due to heavy rain and some flammable and combustible woods. In this Paper, To Detect the Wildfire, Yolov7 Object detection algorithm is proposed. Detection of fire in the deep forest is the most complex task. To make it practical usage of object detection algorithms to detect the fire in different scenarios is done. The Yolov7 has various different features to improve the efficiency of the model. Bounding the images helps in extracting the features from different angles to enhance the detection speed and reduce the negatives. In this paper, the aim is to improve the accuracy by increasing the training sets comparatively more than the test sets.

II. LITERATURE SURVEY

Fire detection approaches for visual recognition fall into two primary categories: conventional methods based on image features and modern methods based on Deep Learning and Machine Learning. Many academics around the world have been researching machine learning techniques to identify forest fires in recent years. Some of the works are described in

this section. As a part of identifying forest fire, Corsican fire dataset and various fire-like objects images were used. Performance of both YOLOv5s and YOLOv5x with and without Test Time Augmentation was presented for the experimental study. In comparison to Yolov5s, Yolov5 large produced the best results due to the high resolution of the input photos [1]. A study based on ensemble learning was conducted in 2021 to compare the efficiency of Yolo v5 and Efficient Net. Here, multiple public fire datasets of different types of forest fires were used to train the system. Yolo v5 was significantly more accurate and better in detecting long-area fires [2]. The Yolo algorithm and deep learning were used to detect fire in the forest. A drone was built with a camera, raspberry pie, and a neural stick as an on-board computer for real-time video processing [3]. An improved high speed flame detection method based on YOLOv7 was proposed. A CN-B network module was built using YOLOv7 and ConvNeXtBlock, and a YOLOv7-CN-B flame detection method was proposed [4].The smokes from the forest fires were detected using a wide range of different YOLOv5 models (YOLOv5s, YOLOv5 m, YOLOv5 l) and loss functions (CIoU, GIoU, DIoU). YOLOv5m was finally used as the benchmark model which gave better results [5].A new framework that lowers the sensitivity of several YOLO detection algorithms is presented in the study. A comparison between various YOLO models, including YOLOv3, YOLOv5, and YOLOv7, and earlier models, like Fast R-CNN and Faster R-CNN, was also conducted. Yolov5x performed better than other models and provided an accuracy rate of 96.8 [6].The effectiveness of YOLOv6, an object identification system based on an NVIDIA GPU platform, in identifying items related to fire was examined. To test the system's ability to recognise fire-related objects, multi-class object identification utilising random forests, k-nearest neighbours, support vector, logistic regression, naive Bayes, and XGBoost was done on the SFSC data [7].The detection and localization of fire in surveillance videos is presented using two CNN models. The first model is based on the SqueezeNet design, while the second model is based on GoogleNet architecture. UAVs are significant for fire detection and monitoring, according to a comparison of ground, satellite, and UAV systems in terms of dependability, adaptability, and efficiency [9].The study proposed a rule-based color model for forest fire pixel classification. The proposed color model makes use of RGB color space and YCbCr color space. The performance of the proposed algorithm is tested on two sets of images; one containing fire and the other with no- fire images. The proposed model achieves 99% flame detection rate and 14% false alarm rate [10].

III. PROPOSED SYSTEM

The proposed fire detection system is built based on the efficiency of Yolov7. Framework outputs the localized version of an image from an input flame of fire. The proposed model's first step is Yolov7. The suggested structure, integrates networks. The network is first fed with photos of forest fires in RGB color which are processed using Yolov7 to obtain the bounding box around the fire area, using Yolov7. Once the output is obtained, the images obtained are cropped and annotated. Yolov7 finds such that only a portion of the bounding box-restricted image is received. The proposed model uses a set of fire images as input. The forest fire dataset is collected from various sources like Corsican Fire, Canopy fire, Ground fire Forestry Images. The fire dataset consists of 1900 images which includes fire images and non-fire images. The dataset is divided into testing and training processes. The training process is segmented as 70% and testing process is segmented to 30%, to obtain best results.

IV. METHODOLOGY

The methodology for the Forest Fire Detection using Yolov7 is summarized as follows:

1) Data Collection: A dataset of Forest Fire images and non-Forest Fire images are collected, consisting of images of with different types of Forest Fires and plain forests.
2) Data Pre-processing: The collected dataset is pre-processed by resizing the images to a standard. Data preprocessing is classified into labeling and orientation.

Labelling: The collected images are separated and filtered manually. The sorted images blended as a whole dataset which contains 1900 fire and non-fire images. Figures 1 and 2 show samples from the dataset.

FIGURE1: FOREST FIRE IMAGE

FIGURE2: NON-FOREST FIRE IMAGE

Orientation:

Data Augmentation:

Random Brightness Augmentation: Variable brightness for the purpose of feeding the deep learning mode, photos with varying brightness levels are produced via image augmentation.

Random Rotation Augmentation: According to the method of augmentation, rotation of the image by 0 to 360 degrees clockwise is done. In this method, the pixels of the image rotate.

Random Flip Augmentation: A pre-processing layer which randomly flips images during training. This layer will flip the images horizontally and or vertically based on the mode attribute. Depending on the mode parameter, this layer will either flip the photos horizontally or vertically. The output will be the same as the input throughout inference time.

V. CONCLUSION

In this paper, a method of forest fire detection based on YOLOv7 is introduced. Using Corsican Fire dataset and various fire-like objects images, Evaluated in these methods. The proposed model will help the forest departments of various vastly spread forests in early detection of forest fire and will ease the work of those departments. The model has taken various works under the Forest fire Detection to help and understand the risk factors which cause Forest fires. The improvement can be done through the Ensemble Algorithm for better Prediction and Detection of Forest fire, in which it encourages to help Fire Fighters to battle forest fire.

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