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FIRE AND SMOKE DETECTION IN FOREST USING YOLOV8

[1]Dr.N.Sai Sindhuri, [2]SK.Jasmin

Abstract: The performance of Yolo V8 when compared to traditional approaches such as infrared imaging has been thoroughly studied and documented. Studies have found that the algorithm is more accurate in detecting fires before they become too severe or spread too far, allowing for quicker response times from firefighting units. For solving this problem, we developed a detection model called upgraded-YOLO based on the state-of-the-art object detection method of YOLOv8. The proposed model is able to perform real-time object detection. Firstly, the data will be collected and data labelling is performed. Unlike other objects detection models that divide image into multiple regions and perform object detection on multiple regions, YOLOv8 performs object detection on entire image in one forward pass through the network. This makes it fast and efficient for real time applications. A comparative study with several contemporary object detectors proved that the Upgraded-YOLO performed better. Therefore, the proposed detection technology can be deployed in a monitoring center in order to protect a strategic installation even in low-visibility conditions.

***Index Terms* -forest fire, detection, smoke alert, computer vision, yolo model, deep learning.**

I. INTRODUCTION

Forest is one of the major wealth of our country. Forests provide enormous material goods and environmental services. They are useful for industry as well as rural economic growth. Forests provide timber, resins, rubber, food items, medicines etc. Forests also provide best environmental service to the world. The trees in the forests produce oxygen by photosynthesis, which reduces global warming. Forests absorb carbon dioxide which is a raw material for photosynthesis. Forests prevents soil erosion, absorb toxic gases. Forests are the homes for wild animals. At the same time, when the forest is under fire it emits lot of carbon dioxide leads to climate change and global warming. So the forest fire has to be detected at earlier stage. Due to isolation, inaccessibility, tough weather, shortage of frontier staff, the early finding of forest fire is a difficult task.The goal of this project is to detect the forest fire and smoke easily by using YOLOv8 algorithm.The objective of this project is to detect the forest fire and smoke in forest by giving inputs as image, video, YouTube URL and webcam by using latest version of YOLOv8 algorithm. We can implement in the real time monitoring.

II. LITERATURE REVIEW

Automatic fire pixel detection using image processing: A comparative analysis of Rule-based and Machine Learning- based methods,Tom Toulouse, Lucile Rossi, Turgay Celik

This paper presents a comparative analysis of state-of-the art image processing-based fire color detection rules and methods in the context of geometrical characteristics measurement of wildland fires. Two new rules and two new detection methods using an intelligent combination of the rules are presented, and their performances are compared with their counterparts. The benchmark is performed on approximately two hundred million fire pixels and seven hundred million non-fire pixels extracted from five hundred wildland images under diverse imaging conditions. The fire pixels are categorized according to fire color and existence of smoke; meanwhile, non-fire pixels are categorized according to the average intensity of the corresponding image. This characterization allows to analyze the performance of each rule by category. It is shown that the performances of the existing rules and methods from the literature are category dependent, and none of them is able to perform equally well on all categories. Meanwhile, a new proposed method based on machine learning techniques and using all the rules as features outperforms existing state-of-the-art techniques in the literature by performing almost equally well on different categories. Thus, this method, promises very interesting developments for the future of metro logic tools for fire detection in unstructured environments.

Intelligent algorithm for smoke extraction in autonomous forest fire Detection,Ivan Grubisic, Darko Kolaric and Karolj Skala

Forest fire, if not detected early enough, can cause great damage. In order to reduce it, it is vital to detect fire as soon as possible and act upon it. In its early stage, forest fire manifests itself primarily as smoke, as flames are too little to be seen. Therefore, to ensure forest fire detection in its earliest stages, smoke detection is utilized. Autonomous forest fire detection based on smoke detection is currently one of the greatest challenges in image processing field. The main reason for it is that there are lots of smoke-resembling natural phenomena such as clouds, cloud shadows and dust. So the essence of the problem lies in separating these phenomena from real smoke. In this article we propose a smoke detection algorithm that combines motion detection, edge detection, spectrum analyzing and moving shape analyzing algorithms, matched together to increase detection rate and to decrease false alarm rate.

Forest Fire Smoke Video Detection Using Spatiotemporal and Dynamic Texture,Zhong Zhou and Mingming Xu

Smoke detection is a very key part of fire recognition in a forest fire surveillance video since the smoke produced by forest fires is visible much before the flames. The performance of smoke video detection algorithm is often influenced by some smoke-like objects such as heavy fog. This paper presents a novel forest fire smoke video detection based on spatiotemporal features and dynamic texture features. At first, Kalman filtering is used to segment candidate smoke regions. Then, candidate smoke region is divided into small blocks. Spatiotemporal energy feature of each block is extracted by computing the energy features of its 8-neighboring blocks in the current frame and its two adjacent frames. Flutter direction angle is computed by analyzing the centroid motion of the segmented regions in one candidate smoke video clip. Local Binary Motion Pattern (LBMP) is used to define dynamic texture features of smoke videos. Finally, smoke video is recognized by Adaboost algorithm. The experimental results show that the proposed method can effectively detect smoke image recorded from different scenes.

Forest fire flame and smoke detection from UAV-captured images using fire-specific color features and multi-color space,E.M. Anim Hossain, Youmin M. Zhang and Masuda Akter Tonima

In recent years, the frequency and severity of forest fire occurrence have increased, compelling the research communities to actively search for early forest fire detection and suppression methods. Remote sensing using computer vision techniques can provide early detection from a large field of view along with providing additional information such as location and severity of the fire. Over the last few years, the feasibility of forest fire detection by combining computer vision and aerial platforms such as manned and unmanned aerial vehicles, especially low cost and small-size unmanned aerial vehicles, have been experimented with and have shown promise by providing detection, geolocation, and fire characteristic information. This paper adds to the existing research by proposing a novel method of detecting forest fire using color and multi-color space local binary pattern of both flame and smoke signatures and a single artificial neural network. The training and evaluation images in this paper have been mostly obtained from aerial platforms with challenging circumstances such as minuscule flame pixels, varying illumination and range, complex backgrounds, occluded flame and smoke regions, and smoke blending into the background. The proposed method has achieved F1 scores of 0.84 for flame and 0.90 for smoke while maintaining a processing speed of 19 frames per second. It has outperformed support vector machine, random forest, Bayesian classifiers and YOLOv3, and has demonstrated the capability of detecting challenging flame and smoke regions of a wide range of sizes, colors, textures, and opacity.

An insight to forest fire detection techniques using wireless sensor networks,Pradeep Kumar Singh, Amit Sharma

Fire is a threat to our forests. Human intervention is one the major cause of forest fires. In addition to destroying wooden areas fire jeopardizes our safety. The risk of forest fires has increased in Hilly around the globe in recent past years due to development and building constructions. In order to detect the forest fire several attempts have been made using different techniques from optical fire sensor, satellite based methods and wireless sensor networks. Early detection of forest fire is most important and may save the resources and wealth of forest. In this paper, we have analyzed the existing forest fire detection techniques limited to wireless sensor networks only. Numbers of popular wireless sensor network based forest fire detection techniques have been explored and their merits along with the demerits are reported during the findings.

Forest fire and smoke detection using deep learning-based learning without forgetting,Veerappampalayam Easwaramoorthy SathishKumar,Jaehyuk Cho

Forests are an essential natural resource to humankind, providing a myriad of direct and indirect benefits. Natural disasters like forest fires have a major impact on global warming and the continued existence of life on Earth. Automatic identification of forest fires is thus an important field to research in order to minimize disasters. Early fire detection can also help decision-makers plan mitigation methods and extinguishing tactics. This research looks at fire/smoke detection from images using AI-based computer vision techniques. Convolutional Neural Networks (CNN) are a type of Artificial Intelligence (AI) approach that have been shown to outperform state-of-the-art methods in image classification and other computer vision tasks, but their training time can be prohibitive. Further, a pretrained CNN may underperform when there is no sufficient dataset available. To address this issue, transfer learning is exercised on pre-trained models. However, the models may lose their classification abilities on the original datasets when transfer learning is applied. To solve this problem, we use learning without forgetting (LwF), which trains the network with a new task but keeps the network's pre-existing abilities intact.

UAV-based forest fire detection and tracking using image processing techniques,Chi Yuan, Zhixiang Liu, Youmin Zhang

In this paper, an unmanned aerial vehicle (UAV) based forest fire detection and tracking method is proposed. Firstly, a brief illustration of UAV- based forest fire detection and tracking system is presented. Then, a set of forest fire detection and tracking algorithms are developed including median filtering, color space conversion, Otsu threshold segmentation, morphological operations, and blob counter. The basic idea of the proposed method is to adopt the channel "a" in Lab color model to extract fire-pixels by making use of chromatic features of fire. Numerous experimental validations are carried out, and the experimental results show that the proposed methodology can effectively extract the fire pixels and track the fire zone.

Image Texture Classification using Gray Level Co- Occurrence Matrix Based Statistical Features Annamalai Suresh

In this paper, a novel texture classification system based on Gray Level Co-occurrence Matrix (GLCM) is presented. The texture classification is achieved by extracting the spatial relationship of pixel in the GLCM. In the proposed method, GLCM is calculated from the original texture image and the differences calculated along the first non singleton dimension of the input texture image. Then the statistical features contrast, correlation, energy and homogeneity are calculated from both the GLCM. The extracted features are used as an input to the K Nearest Neighbor (K-NN) for classification. The performance of the proposed system is evaluated by using Brodatz database and compared with the methods PSWT, TSWT, the Gabor transform, and Linear Regression Model. Experimental results show that the proposed method produces

III. PROPOSED METHODOLOGY

The YOLO (You Only Look Once) algorithm is an object detection algorithm used in computer vision and deep learning. It was first introduced by Joseph Redmon, Santosh Divvala, Ross Girshick, and Ali Farhadi in 2015. YOLO is known for its real-time object detection capabilities and has been widely adopted in various applications, including autonomous vehicles, surveillance systems, and robotics. The main idea behind YOLO is to treat object detection as a regression problem. Instead of using a sliding window or region proposal-based approach, YOLO divides the input image into a grid and predicts bounding boxes and class probabilities directly from the grid cells.

YOLOv8: YOLOv8 is the latest version of YOLO by Ultralytics. As a cutting-edge, state-of-the-art (SOTA) model, YOLOv8 builds on the success of previous versions, introducing new features and improvements for enhanced performance, flexibility, and efficiency. YOLOv8 supports a full range of vision AI tasks, including detection, segmentation, pose estimation, tracking, and classification. This versatility allows users to leverage YOLOv8's capabilities across diverse applications and domains.

ADVANTAGES OF YOLOv8:

The Yolov8 algorithm is an incredibly powerful tool for quickly detecting forest fires and other fire hazards. Its speed of identification is one of its main advantages, as it can scan through images or videos in real time and identify any signs of burning trees or smoke plumes. This makes it more efficient than traditional methods such as infrared imaging, which are often slower to react and require manual input from firefighters on the ground.

Another advantage of Yolov8 over traditional methods is its accuracy in detecting fire hazards. By leveraging deep learning techniques, the algorithm has been proven to be more effective at identifying fires before they become too severe or spread too far. This increases the chance that firefighters will be able to respond faster and with greater accuracy when tackling a blaze.

Finally, another key benefit of using Yolov8 for fire detection is its cost effectiveness compared to other means available on the market today. The technology requires minimal hardware setup, meaning that users can easily deploy it without needing extensive investments into expensive equipment or software licenses. Furthermore, since computer vision algorithms such as this one do not need human interaction once set up correctly – which also reduces costs associated with labor – organizations stand to save money by investing in this type of solution instead of more traditional approaches like infrared imaging systems.

Enhancements in YOLOV8:

The YOLOV8 is similar to other versions of YOLO with some special enhancements:

Anchor free detections

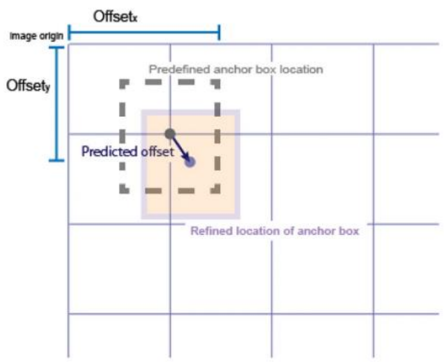

Fig 1. Anchor free detections

Anchor-free detection is when an object detection model directly predicts the center of an object instead of the offset from a known anchor box. Anchor boxes are a pre-defined set of boxes with specific heights and widths, used to detect object classes with the desired scale and aspect ratio. They are chosen based on the size of objects in the training dataset and are tiled across the image during detection. The network outputs probability and attributes like background, IoU, and offsets for each tiled box, which are used to adjust the anchor boxes. Multiple anchor boxes can be defined for different object sizes, serving as fixed starting points for boundary box guesses.

Working of YOLOV8 Algorithm

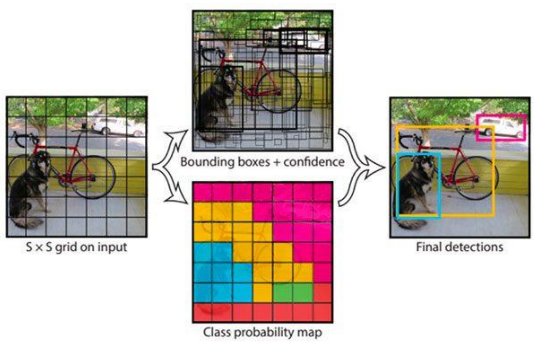

Fig 2. Working of YOLO Algorithm

Input Image: The algorithm takes an input image and resizes it to a fixed size suitable for processing. This size is usually determined based on the network architecture used.
Grid Division: The image is divided into an S x S grid, where each grid cell is responsible for predicting objects present in that cell.
Bounding Box Prediction: Within each grid cell, YOLO predicts multiple bounding boxes. Each bounding box is defined by five attributes: (x, y, w, h, confidence). The (x, y) coordinates represent the center of the bounding box relative to the grid cell, while w and h represent the width and height of the box. The confidence score indicates how confident the algorithm is that the box contains an object.
Class Prediction: Along with the bounding box predictions, YOLO also predicts the probabilities of different classes for each box. The number of class probabilities depends on the dataset being used. These class probabilities represent the likelihood of each class being present in the bounding box.
Confidence Thresholding: YOLO applies a confidence threshold to filter out low-confidence predictions. Bounding boxes with confidence scores below the threshold are discarded as false positives.
Non-Maximum Suppression (NMS): To eliminate duplicate detections and improve accuracy, YOLO applies non-maximum suppression. NMS removes redundant bounding boxes that have significant overlap and keeps only the most confident one. The overlap threshold for suppression is typically determined by a predefined Intersection over Union (IoU) value.
Final Output: The output of the YOLO algorithm is a set of bounding boxes, each associated with a class label and confidence score. These bounding boxes represent the detected objects in the input image.

The specific steps in the implementation procedure goes as follows.Downloading dataset from Roboflow and importing YOLOV8 from ultralytics library.Once the dataset is loaded train the model using pretrained model and save the weights file for testing and deployment.Obtaining the weights file and using that file in the streamlit web application is the end point of the concept.

Streamlit is an open-source Python library used for building and deploying data-driven web applications. It simplifies the process of creating interactive and user-friendly interfaces for data analysis, machine learning, and visualization. Streamlit allows developers and data scientists to focus on the core functionality of their applications without worrying about the underlying web development aspects. Streamlit is widely used by data scientists, machine learning engineers, and developers to create interactive dashboards, data exploration tools, and machine learning prototypes. Its simplicity, rapid development workflow, and intuitive interface make it a popular choice for building data-driven applications.

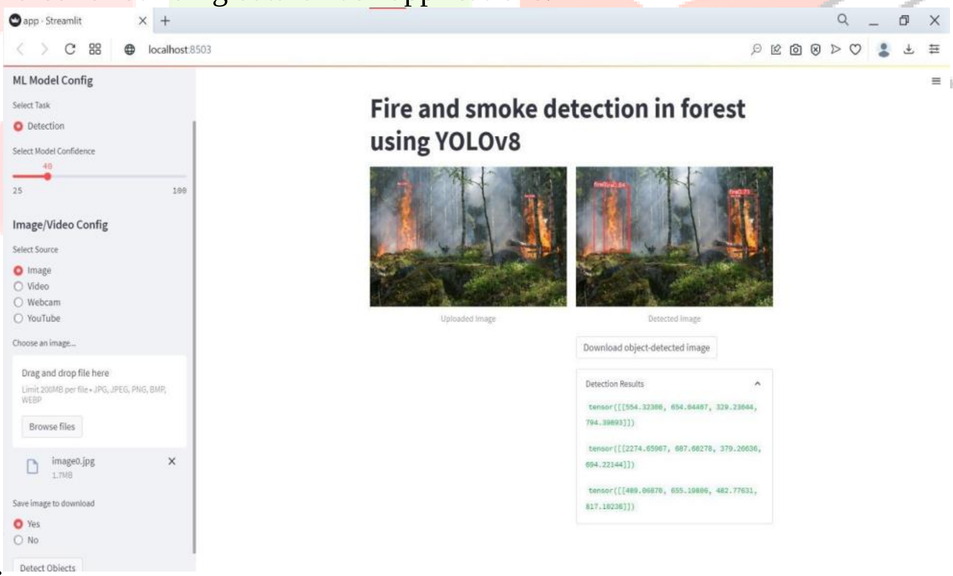

Fig 1. Streamlit Webapp for the Detection Model

With mutliple media like Images,Video Source,Webcam,Youtube URL and other respective media.The model able to detect smoke and fire with good confidence which you can see in the Fig 1.

IV. CONCLUSION

In this paper, we have used YOLO(You Look Only Once)V8 object detection system to train food images dataset and after training we can use this model to detect the food items in a plate and estimate the number of calories per gram from a calorie-chart. This model has successfully detected 30 classes of food items as mentioned in the dataset and successfully estimated the number of calories in them per gram. Our accuracy is

93.1 when trained through 48 epochs. This model is fast and accurate than other CNN-based models as it detects objects in a single shot rather than two stage detection.

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