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Early Fire Detection Alarm Based on Camera Vision

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ABSTRACT— Fire is an ongoing hazard to natural infrastructure and human lives. There have also been other fires in the past. It is seen as a major environmental issue since it seeks to reveal low-cost environmental harm while endangering human lives. Today, there are multiple such systems, but they are not as powerful as the situation requires. As a consequence, a novel method for detecting focus using infrared pictures is suggested. To develop more efficient and dependable procedures, we employ computer vision and instruments. The device also employs a histogram based mostly on segmentation and brightness levels, as well as picture processing. All of this is done to improve in accurate and get the system better suited for real-time applications. As a result, the suggested technology overcomes the current problems and introduces a new and effective way. YOLO V3 was utilised as the classifier in this example to categorise based on the parameters gathered during training. The binary cross-entropy loss function is used to calculate the efficiency of the model. Accuracy is utilized as a measure for evaluation. One key objective of this research is to discover the presence of flame as fast as feasible.

KEYWORDS— Fire accidents, Machine Learning, Deep Learning, Convolutional Neural Network, Optimization Algorithm, Loss Function, YOLOv3.

I.INTRODUCTION

Fires are the most common type of threat in woods. Fire-related mishaps are as old as the forests themselves. They harm not just the forest's richness, but also the entire fauna and flora regime, severely upsetting an area's bio-diversity, ecology, and ecosystem. During the summer, when temperatures are high and there has been no rain for months, the forest gets covered with dried senescent leaves and twinges that, if lit by the least spark, may burst into flames. The Garhwal Himalayas in India have burned often in recent summers, resulting in substantial vegetation loss in that region. Many fires start from natural causes, such as lightning striking a tree. Fires can also start when a combustible item comes into touch with a source of ignition, such as a blow torch, cigar or bidi, incandescent light, or any other form of ignition.

The National Interagency Fire Subject to critical 50,477 wildfires in 2019, up from 58,089 in 2018. (NIFC). Over 4.7 million acres were burnt in 2019. According to the US Department of Interior, 90% of wildfires in the US are caused by residents. Unattended campfires, burning debris, Half-smoked cigarettes ,deliberate arson are both examples of human-caused fires. The other 10% are initiated by lightning or lava.

Fire occurrences are classified into three types:

- 1.Accidental fires, whether natural or man-made
- 2.Fires are often triggered by heat generation in the litter and other biomes during the summer season as a result of human irresponsibility (human neglect).
- 3.Intentionally caused fires by local inhabitants.

Fires are frequently seasonal. They usually start in the summer and may be avoided with adequate precautions. Only a steady supply of fuel, i.e. dry vegetation along the route, will allow the fire to spread. Previous Five-Year Plans included funding for fire occurrences. During the British era, summer fires were avoided by eliminating forest debris all along the forest boundaries. This line was known as the "Fire Accident Line," and it was used to halt forest fires from spreading. The gathered rubbish was burnt in isolation. As a result, precise and fast wildfire detection is



crucial. There are several technical options accessible. The vast majority are sensor-based and only function indoors. Ionization recognizes the presence of fire and smoke particles and needs closeness to the fire. As a precaution, it should not be used in big covered areas. Furthermore, devices are unable to offer particular information such as the position of the first fire, the rising direction of smoke, the extent of the fire, the pace of burn growth, and so on. Early identification of fires before they become big disasters is critical to avoiding disaster and preserving folk's lives and property. Although smoke and flame detection sensors are extensively employed in internal rooms, they typically need that the fire burn for a lengthy period of time in order to create a large quantity of carbon, which further activates the alarm. Furthermore, these gadgets are not appropriate for use in large-scale outdoor environments like forests or wild regions. On the other hand, vision-based fire detection systems are ideal for early fire detection as they capture images from a camera and immediately identify a fire. This type of equipment is relatively inexpensive and easy to install. In this study, a vision-based fire detection method that can be used with a fixed camera is proposed. Our fire detection systems can be attached to large fire detection unmanned aerial vehicles (UAVs). Several vision-based fire detection systems have been reported in the literature. Fire has very distinct characteristics compared to other objects, and it is mainly used in terms of color model, movement, space and time. Almost all of the approaches presented employ a comparable detection pipeline, first identifying shifting pixels via background removal and then recognising patches of fire colour using the colour model. These zones are then analysed geographically and chronologically in order to discover erratic and flashing fire characteristics. Due to the importance of mobility, these systems can only be used with stationary cameras, such as in surveillance situations. These limitations are not limited to the approaches described in this paper. Generate feature representations from data using powerful, state-of-the-art deep learning techniques and train a discriminant classifier to detect fire zones. Deep convolutional neural networks (YOLOv3), specifically YOLO v3, are used as training machines. Although sensors have become widespread due to their low cost and ease of use, they have inherent limitations that are difficult to overcome. First of all, these sensors need to be placed near a fire because they are easily damaged at high temperatures. They can also only be used in small or limited spaces. To address the short comings of previous smoke detection systems, new video-based smoke detection systems have become popular in recent years and offer significant advantages over traditional sensor-based systems. Real-time monitoring of fires has always been important for maintaining forests, especially large forests that require monitoring to minimize economic losses. Thus, "Early Detection and Early Rescue" is the objective of forestry fire danger prevention and management. With advancements in UAV technology, remote sensing, and information processing technology, it is now feasible to process and analyse photos in real time, allowing airborne images to be used to locate fires.

II.EXISTING SYSTEM

Sensor technology is often employed in the detection of fires. Physical characteristics such as oxygen, humid, and warmth, in addition to process conditions including such co2, carbon monoxide, and nitrogen dioxide, can be detected. Furthermore, concerns like as high cost, sensor energy consumption, plus closeness of the detector to the fire for precise detection make these sorts of systems challenging to deploy in vast open areas, and physical.

1. The current system is built on CNN.
2. The existing system leverages old machine learning methods that have not been updated and are thus ineffective in today's climate.
3. Furthermore, the current system is unreliable and is said to be unstable in the presence of large amounts of data.

Because of the requirement for regular deployment of sensors in close proximity, covering huge areas of forest in a fire detection system is impractical, and battery charging is a substantial impediment. The majority of them are sensor-based and only operate indoors. Ionization will be employed to detect the presence of fire and smoke particles, which requires close proximity to the fire. As a result, they are not suitable for usage in a large confined location. Furthermore, they are unable to provide details on the origin of the fire. the direction of smoke propagation, the size and development of the fire, and so forth. Image fire detection systems are used to circumvent such constraints. The image processing model has a faster reaction time and a lower response time than existing image processing systems.

III. LITERATURE SURVEY

[1] *TITLE*: The optimization of geographic information systems for the risk assessment of fire incidents.

AUTHOR: Matrina PETKOVIC, Iva GAVANOV, Dragan KNEZEVIC, Slavoljub ALEKSIC

Fire accidents are natural disasters characterised by uncontrolled and unregulated migrations of fire through woody areas. Fires are growing increasingly prevalent, and they are frequently of significant size, threatening not just woodlands but also crops, residential areas, and human lives. Prevention, detection, and extinguishment are the three crucial steps in firefighting. As a way of protecting forest biodiversity, this project investigates fire prevention measures as well as forest monitoring systems. Using cutting-edge information technology, like as geographic information systems (GIS), may enhance strategic and tactical planning, as well as firefighting operations. The paper highlights the application of selected information systems in the prevention of fire accidents in Serbia.

PUBLICATION: 2020 21st International Symposium on Electrical Apparatus & Technologies (SIELA)

[2] *TITLE*: Random Forest model evaluation for predicting fire incidents over Borneo based on climatology

AUTHOR: Arnida L. Latifah, Ayu Shabrina, Intan N. Wahyuni, RifkiSadikin.

In Indonesia, fire outbreaks have reached worrisome proportions. It is becoming a deadly seasonal phenomenon in the tropics. Borneo, Indonesia's largest tropical forest, is the most prone to fire, especially in dry conditions. Climatic, human activities, and natural processes all pose fire hazards, but only climate elements can be adequately quantified in Borneo. The goal of this research is to evaluate the random-forest model's capacity to anticipate fire events using climatic parameters and satellite data from burned areas. The goal of fire accident prediction is to reduce the impact of future fires. Based on yearly variability and geographical analysis, the random forest model with all required climatic elements can mimic the occurrence of fire occurrences over Borneo.

PUBLICATION: 2019 International Conference on Computer, Control, Informatics and its Applications (IC3INA)

[3] *TITLE*: Aerial Fire accidents Surveillance - Evaluation of Fire accidents Detection Model using Aerial Videos.

AUTHOR: Hanh Dang-Ngoc, Hieu Nguyen-Trung.

Unmanned aerial vehicles (UAVs) can provide an aerial perspective for rapid response in large disaster areas and have recently been used to monitor fire incidents. This study investigates one of the popular models for fire incident detection using aerial film to demonstrate its robustness for real-world use in aerial fire incident monitoring. Fire rate and color features are used to extract fire pixels. The performance of the fire detection model was evaluated in our previous work using a huge database of different scene - settings and showed its effectiveness and shortcomings. Our collection includes 49 aerial recordings with a total of 16,898 fire incident frames. Our fire incident detection algorithm has an accuracy of 93.97%, but the false alarm and error rates are 7.08% and 6.86%, respectively. In our fire detection model, the thickness of smoke covering almost the entire fire is the main cause of misdetection. In this work, we propose an additional step for smoke detection to improve the detection performance. Segment smoke pixels using smoke color and motion features. The results show that the smoke detection stage can help locate the fire in the presence of smoke.

[4] *TITLE* : Early Detection of Fire accidents Based on Unmanned Aerial Vehicle.

As a kind of herbal useful resource, the wooded area is essential to our survival. Once the fire takes place inside the wooded area isn't observed in time, it can result in a massive loss. Accurate real-time tracking of fire accidents is not simply a crucial part of fire prevention but additionally a crucial way to efficiently



control the unfold of fire accidents and decrease monetary losses. The areas of the Forest are often geographically widely distributed and inefficient in guide inspections. Therefore, we need a tremendous cell early heart coincidence warning system to ensure the protection of forest resources. UAVsserveas is an incredibly mobile inspection device to fulfill inspection necessities for fireplace injuries. Besides, the early flame characteristics are not obvious, and the unmarried supply fireplace detection is simple to a false alarm. In view of this, we suggest a fireplace accident detection approach that makes use of optical photographs to stumble on smoke and infrared pics to hit upon the fireplace.

[5]TITLE: Speculation of Fire accidents Using Spatial and Video data.

AUTHOR: T.L. Divya;M.N. Vijayalakshmi, Anupama kumar

Fire accidents are herbal calamity that causes significant loss to the ecology. The flora had a notable loss by the high severity of the fire. So this fire must be detected inside forest regions on the way to store flowers. Currently, frameworks are to be had with the picture processing machine which does evaluation over the static heart accidents photograph which gives facts on fire warm spots. The motion/motion of hearth evaluation with woodland zone evaluation is a difficult task with such static pies. With non-stop monitoring of the fire with movies, this hassle may be solved. Hence proposed framework presents novel heart injuries flame movement analysis devices primarily based on spatiotemporal features using films.

PUBLICATIONS: 2019 International Conference on Advanced Technologies for Communications (ATC).

IV. PROPOSED SYSTEM

The model will be run on portable NeuralNetwork computer sticks, such as those made by Intel. The UAV's camera takes photographs in real time, and we use open-source computer vision OpenCV to extract frames from the 30fps stream at 1 frame every 120 frames, producing a yield of around 1 frame every 4 seconds. This frame is then sent into the software, which anticipates a wildfire and uses geospatial tagging to locate its exact location. The GIS module is used for location tagging, which is not covered in this project. Using the positive and negative images, we built a complete image classifier. A negative image lacks any fire patches, whereas a positive image contains at least one fire patch. Because our dataset is small, training a complete image classifier from scratch may result in overfitting. The most successful strategy to train a YOLOv3 classifier on a constrained dataset is by fine-tuning, which may transfer previously learned network parameters to the new model. Performance is crucial since YOLOv3s are complex models with several learnable parameters. As a result, YOLOv3s are frequently trained on GPUs rather than central processing units (CPUs) (CPUs). GPUs are bits of hardware that are specifically intended to perform the numerous parallel matrix operations required for graphics processing. YOLOv3s benefit from a high level of parallelization since they are inherently parallel. As the learning algorithm, the Rms prop Optimization Algorithm was used.

ADVANTAGES:

- The proposed technology has a much higher accuracy of 92% and is also more energy efficient.

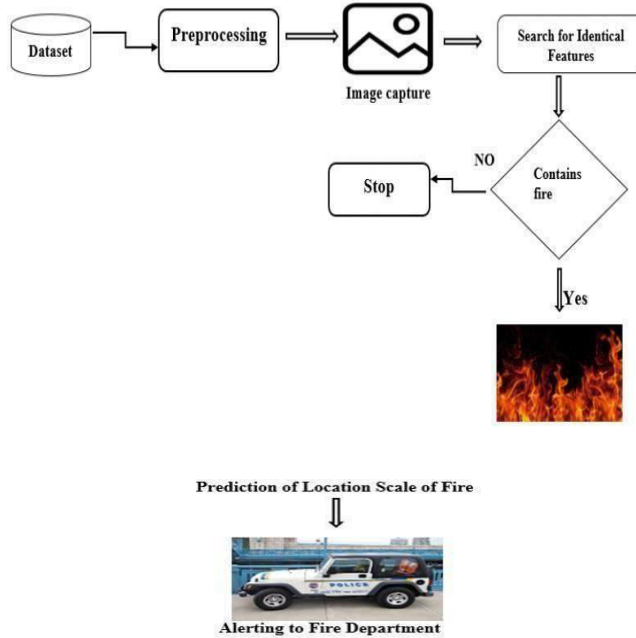


Fig . 1 Architecture diagram

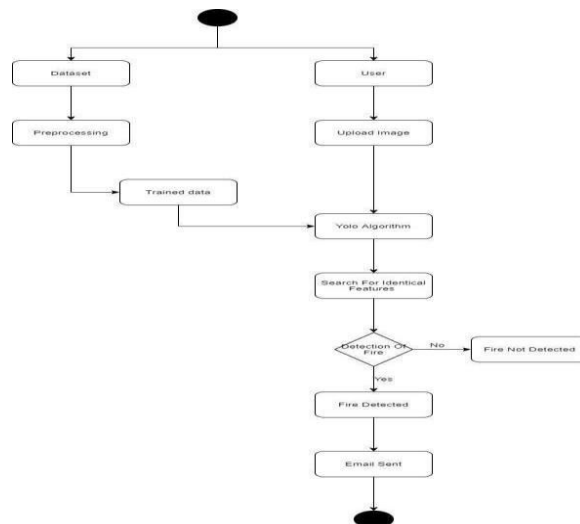


Fig.2.ACTIVITY DIAGRAM

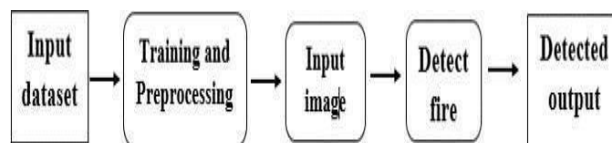


Fig.3.DATAFLOW DIAGRAM

V. MODULES

1. MODEL CONSTRUCTION AND DATA INPUT

- The model is implemented using Anaconda and the language used is python.
- The data is first preprocessed to fill in any missing values
- The preprocessed data is then divided into training and testing instances to train the algorithm.
- Then, the model is built by adding convolutional layers for increased complexity, max pooling layer, flattening, and dense layers.
- The model is then compiled with an RMS prop optimizer. For getting accuracy the metric is used to evaluate the model.
- Image augmentation is performed to enrich the dataset and to avoid over-fitting.
- The dataset is fitted to the model and the model is trained with 20 epochs.
- The model's accuracy and the model's loss over the epochs are depicted in the form of a graph.
- In this module we input the data that is required to predict the fire accidents and come up with a defined set of values which would state if the wildlife fire is possibly happening or not, in any case, the main module is the input module where the data are implemented.
- In this module the data can be directly added via GUI or through an end point connection which can be able to produce the output if there is fire accidents or not.

2. LOADING THE MODEL AND AUGMENTATION

- The model that is trained and saved is loaded.
- The model is then compiled and the image is fed to the model
- The model reads the image using Python Image Library
- Output with the prediction is displayed.
- In this module the previous input data gets preprocessed into the required raw format and is processed into the augmentation module to carry over the training module which feeds the data into its machine learning system and compares it with those of the pre-trained datasets which essentially makes the process more efficient and easier.

3. DATA PROCESSING MODULE

- This is the main module where all the data processing and developing happens, this is where the machine learning methods get trained with the new and existing datasets and develop a graph accordingly to the curve of the output methods
- This process which also increases the rate of finding the output module with more efficiency and accuracy to predict and find the fire accidents methods that has evolved.

4. ALERT SYSTEM MODULE

- In this module we predict the data and come up with a solution and some key insights which tells us the rate of the prediction and if there is any fire accidents in the predicted values the system automatically alerts the required personnel in charge and also send an email to the required connects who can be able to solve the issue immediately.
- If there is no fire accidents there won't be any notification till anything unusual happens in the system of choice to come up with sudden notification on fire as soon as the activity arises in the premises.



VI. CONCLUSION

This paper proposes a method for detecting fire accidents in a forest area using photographed data, accompanied by desktop processing of the information using only a technique for reading stuff, which was before of digital image parts, data processing as well as records categorisation using root - mean - square prop optimization technique, and trying to predict the accurateness of fire accidents. The suggested approaches are effective: 88percent of the yearly data is information-related, and 27.90percent is false detection. The offered technique can be utilized for local fire warning surveillance systems.

VIII. FUTURE SCOPE

The suggested identification and alerting program's performance can be boosted further by considering smoking in the initial phases of a fire. Smoke detection, on the contrary hand, is a complicated task that is prone to considerable false detections owing to changing light sources, mist, outside optical transmittance, as well as other natural causes. By inspecting each smoke-like place, similarly high false alarm rates can be decreased. This, however, imposes a significant computational overhead. Furthermore, by using videos rather than camera images, we can track the progress of flames over time. Additionally, the type of fire might be utilised to decrease the number of alarms falseness.

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