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Forest Fire Detection Using Deep Learning Techniques

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Abstract - *Forest-fires are real threats to human lives, environmental systems and infrastructure. It is predicted that forest fires could destroy half of the world's forests by the year 2030. The only efficient way to minimize the forest fires damage is adopt early fire detection mechanisms. Thus, forest-fire detection systems are gaining a lot of attention on several research centres and universities around the world. Currently, there exists many commercial fire detection sensor systems, but all of them are difficult to apply in big open areas like forests, due to their delay in response, necessary maintenance, high cost and other problems. In this study, image processing based has been used due to several reasons such as quick development of digital cameras technology, the camera can cover large areas with excellent results, the response time of image processing methods is better than that of the existing sensor systems, and the overall cost of the image processing systems is lower than sensor systems. Accurate forest fires detection algorithms remain a challenging issue, because, some of the objects have the same features with fire, which may result in high false alarms rate. This project presents a new video-based, image processing forest fires detection method, which consists of four stages. First, a background-subtraction algorithm is applied to detect moving regions. Secondly, candidate fire regions are determined using RGB colour space. Thirdly, features extraction is used to differentiate between actual fire and fire-like objects, because candidate regions may contain moving fire-like objects. Finally, convolutional neural network algorithm is used to classify the region of interest to either real fire or non-fire. The final experimental results verify that the proposed method effectively identifies the forest fires.*

• INTRODUCTION

Early detection and identification of forest fire can avoid damaging disaster. Fire detection methods such as satellite-based detection, optical sensing, wireless sensing and remote sensing gain notable improvements to forest fire alarm. In this study, we focus on monitoring fire detection driven by computer vision. Computer vision mechanisms for fire detection could be mainly classified into two categories, traditional image processing method and deep Convolutional Neural Network (CNN) method. Existing conventional detection algorithms mainly operate based on visual properties of fire, such as color, spectral, texture, motion and geometric features. Despite the low cost and simplicity, traditional methods strongly rely on appropriate feature description of fire. Some natural phenomena, such as sunset and fog would cause false alarm and missing report to these approaches occasionally. To

solve these problems, a more advanced fire detection scheme proposing the use of CNN technology instead of feature description has attracted more and more attention. Meanwhile, recent development of GPU allows the use of CNN-based methods for flame detection. Common disadvantage of them seems to be that large datasets are required to learn the best features. As a result of this, the model would over-fitted under huge training dataset, whereas applying a small number of dataset for learning would be insufficient. Recently, some lightweight compression networks that could achieve real-time processing have been introduced when reasonable mistakes are allowed.

- **MODULES**

- **Image Acquisition**

Early detection of wildfires is critical to the safety and security of environmental spaces and is one of the important and most large challenges in the government sector and forest fire managers. Forest fire is the important one is decreasing the space of the forest area. This fire detection technique also reduces human protocols and helps to monitor and protect the areas that are hard to protect. The new technique is used to facilitate the implementation of systems that allow monitoring is efficient in detailed areas, regardless of the state of the atmosphere or daytime. In this module, we can upload the image or videos which are captured from CCTV footages in forest. The satellite sensor is used to capture the forest fire image, but it has an increasing range of time resolution and space of the forest area. Satellite images also gave a fire-monitoring tool, management, and finding the damaged tool for compliance with burn areas to understand a favorable fire range. The principle of classifying this fire, such as materials from the original fire, is to check the color consistency. The proposed algorithm has rectified this problem and reduces the error. It not only detects fires but also distinguishes fires such as fire and materials. The parameters that were adopted in our proposed system operation to analyze the forest fire, threshold value, the detection of matrix value, and the differential matrix value of the system. If the input is video means, convert the videos into frames or if the input is images means, it can be any format or size.

- **Preprocessing**

Pre-processing is a common name for operations with images at the lowest level of abstraction both input and output are intensity images. These iconic images are of the same kind as the original data captured by the sensor, with an intensity image usually represented by a matrix of image function values (brightness). Image pre-processing methods are classified into four categories according to the size of the pixel neighborhood that is used for the calculation of new pixel brightness. The aim of pre-processing is an improvement of the image data that suppresses unwilling distortions or enhances some image features important for further processing, although geometric transformations of images (e.g. rotation, scaling, and translation) are classified among pre-processing methods here since similar techniques are used. The user has to select the required lung frame image for further processing. Then each image is resized to 256*256. Then implement median filter to remove noises from fire images. The median filter is a nonlinear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise (but see discussion below), also having applications in signal processing. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. Median filtering is a nonlinear method used to remove noise from images. It is widely used as it is very effective at removing noise while preserving edges. It is particularly effective at removing ‘salt and pepper’ type noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighboring pixels. The pattern of neighbors is called the "window", which slides, pixel by pixel over the entire image pixel, over the entire image. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle

(median) pixel value. In this module, convert the RGB image into gray scale and also implement median filtering algorithm to remove the noises in images.

- **Features Extraction**

Feature extraction involves simplifying the amount of resources required to describe a large set of data accurately. When performing analysis of complex data one of the major problems stems from the number of variables involved. Analysis with a large number of variables generally requires a large amount of memory and computation power or a classification algorithm which over fits the training sample and generalizes poorly to new samples. Feature extraction is a general term for methods of constructing combinations of the variables to get around these problems while still describing the data with sufficient accuracy. Texture tactile or visual characteristic of a surface. Texture analysis aims in finding a unique way of representing the underlying characteristics of textures and represent them in some simpler but unique form, so that they can be used for robust, accurate classification and segmentation of objects. Though texture plays a significant role in image analysis and pattern recognition, only a few architectures implement onboard textural feature extraction. In this module implement color and texture features are implemented. HSV color features are extracted and Texture features include statistical features using Grab-cut method. In this module, skin images are segmented using snake model. A snake is an energy minimizing, deformable spline influenced by constraint and image forces that pull it towards object contours and internal forces that resist deformation. Snakes may be understood as a special case of the general technique of matching a deformable model to an image by means of energy minimization. In this module, extract the features related to color or shape features. Based on these features, we can extract the fire regions from images.

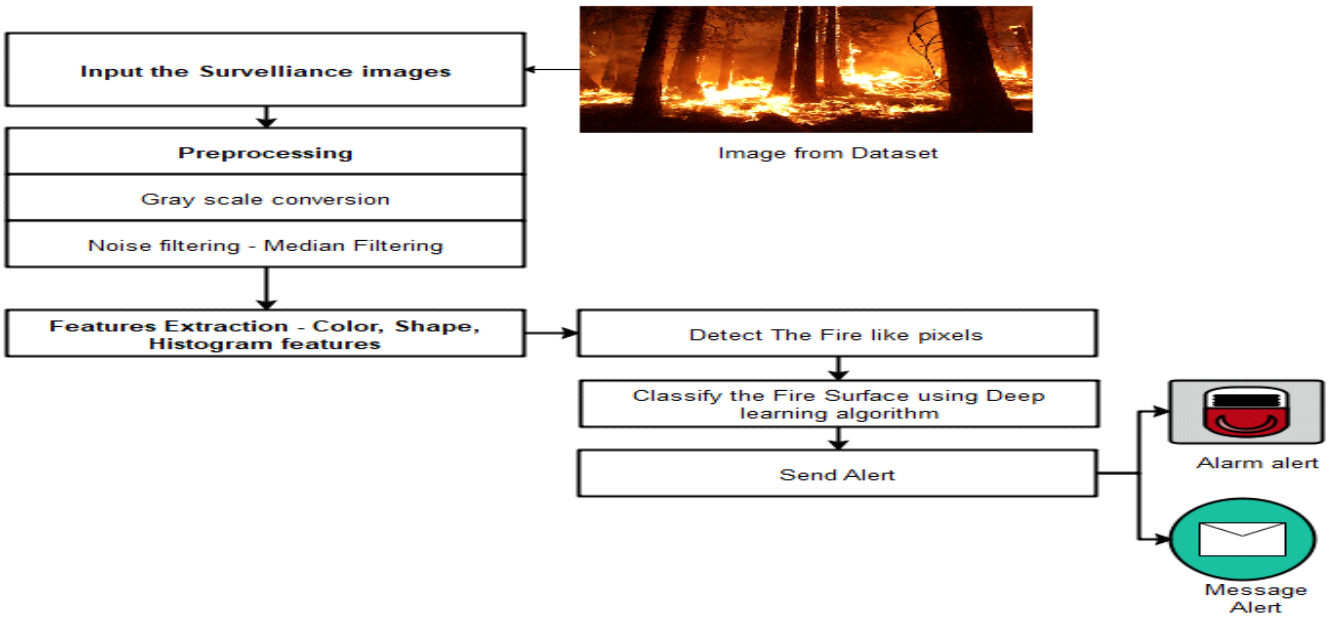
- **Classification**

The classification is the final step of the system. After analyzing the structure, each section individually evaluated for the probability of true positives. Brain diseases are classified using Convolutional neural network algorithm. CNNs represent feed-forward neural networks which encompass diverse combos of the convolutional layers, max pooling layers, and completely related layers and Take advantage of spatially neighborhood correlation by way of way of imposing a nearby connectivity pattern among neurons of adjacent layers. Convolutional layers alternate with max pooling layers mimicking the individual of complex and clean cells in mammalian seen cortex A CNN includes one or extra pairs of convolution and max pooling layers and ultimately ends with completely related neural networks. The hierarchical structure of CNNs is steadily proved to be the most efficient and successful manner to analyze visible representations. We know that CNNs can accomplish competitive and even better performance than human being in some visual problems, and its capability inspires us to study the possibility of applying CNNs for classify the disease features. The CNN varies in how the convolutional and max pooling layers are realized and how the nets are trained. Finally classify the image regions using deep learning algorithm. And then improve the accuracy in classification.

- **Alert System**

The forests as a whole are heavily affected by human activity. The rapid growth of increasing the population and urbanization has led to the outbreak of forest regions. Forest fire is a natural hazard to the environment and the interference of the atmosphere system; the environment affects living organisms. Satellite imagery also provides a fire monitoring, management, and damage assessment tool for compliance with burn areas to understand a favorable fire range. Satellite image refers to the ability of images from dataset images taken in a remote area to receive specific information. In this module, send alert to the authority in terms of SMS at the time of fire detection. It can be useful to provide earlier detection.

- **ARCHITECTURE**



Functional Architecture Diagram for Forest Fire Detection

- **RELATED WORKS**

- **Sensor Based Fire Detection**

Current sensor-based hearth detection styles are introduced to early stages of the detection and supply suppression for observation system. These hearth alarm sensors primarily embrace temperature sensors, smoke sensors, infrared sensors, optical sensors, gas sensors, etc. Quiet al. projected a fireplace detection system mistreatment optical maser chemical analysis CO detector. They adopted an extremely effective microcontroller and straightforward digital lock-in electronic equipment (DLIA) for early hearth warning. Li et al. raised an early hearth detection study known as long-range Raman distributed fiber temperature detector (RDFTS), that achieved most sensing distance at 30 km and an abstraction resolution of 28 m. Though temperature detector might offer single-point mensuration, it's not accessible for long-distance sensing. A photoacoustic gas detector adopting a near-infrared tunable fiber optical maser supported wavelength modulation spectrum analysis technique is rumored by Wang and Wang. This detector provides speedy and targeted measurements of combustion merchandise, particularly C2H2, CO, and CO2 underneath gas pressure. Besides, chemical gas sensors tend to reply faster than smoke particle detectors. However, sensor-based hearth detection system is impractical thanks to the need of standard distributed sensors in shut proximity.

- **Feature Based Fire Detection**

The fire detection algorithms by means that of color feature square measure wide rumored in literatures. Maybach et al. investigated YUV color house and motion options for hearth detection. This technique cannot get time period detection thanks to various parameters and high machine quality. Foggia et al. combined color, form and motion options for time period hearth detection. Generally, color-driven strategies don't seem to be effective enough since the equivalent sensitive to cloud and brightness still, and square measure at risk of confuse moving targets the same as flame color with real flame. Texture description operators, particularly native binary pattern (LBP), square measure typically accustomed analyze texture pictures with flame. The success of those

strategies powerfully depends on the identification of effective fire texture options. As an example, Yuan connected bar graph sequence of LBP with native binary pattern variance pyramid and extracted hearth texture feature for flame detection. Another dynamic texture descriptor with hidden Markoff tree and surface-let rework was conferred by Ye et al. as well. Except for the literatures considering color and texture options mentioned on top of, another previous wide-fire detection algorithms were designed supported options of fireside form and fire-color moving objects. A recent formula thought-about the employment of form invariant options. Generally, create variant options employed in the strategies could lead to the reduction of generalization performances. Motion of flame exist in fire, thus detection algorithms supported motion behavior of fireside are rumored. As an example, in, Yu et al. addressed a video hearth detection formula mistreatment color and motion options. Mueller et al. projected a machine vision-based flame detection model via exploring motion options supported motion estimators. Completely different from rigid objects with clear contour, fire has numerous form, color and moving direction variable throughout time. As a result, it's tough for those detection algorithms to make supported the options of extracted from hearth.

- **EXISTING SYSTEM**

Early fire detection in the event of an outbreak is pivotal to prevent loss of life and properties. The existing system implements machine learning algorithm named as support vector machine to detect the fire like pixels. And it uses YCbCr color space to detect the fire like pixels with object detection.

DRAWBACKS

It does not support multiple backgrounds. Naked eye method can be used in traditional system. Machine learning algorithm called Support Vector Machine is implemented to detect the forest fire. Classification accuracy is less.

- **PROPOSED SYSTEM**

The proposed system can implement pre-processing steps to eliminate the noises in images. And also, it implements features extraction to extract the colour features and segment the fire regions. Finally, it classifies the pixels using deep learning algorithm with efficient mobile alert system to corresponding authorities

EXPECTED OUTCOME

Our system helps with automated analysis of fire detection. It reduces the time and computational complexity. It has improved accuracy rate. The relevant features are extracted.

- **REQUIREMENTS**

Hardware Requirements:

- Operating System : Windows 10
- Language Used : C#, Python
- Back End : SQL SERVER
- Software & IDE : Visual studio
- Application : Windows Application

Software Requirements:

- Processor : i3 processor and above
- RAM : 4 GB or more

- Hard disk : 20 GB or more
- Internet Bandwidth : At least 5 Mbps

- **TEST CASE**

S.NO	FUNCTION	DESCRIPTION	EXPECTED OUTPUT	ACTUAL OUTPUT	STATUS
1	Upload image	Train and test the image	Image in home page	Image in home page	Success
2	Pre processing	Gray scale conversion and noise filtering	Remove the noises in image	Enhanced image	Success
3	Features extraction	Fire like pixel identification	Color and shape features extracted	Color and shape features extracted	Success
4	Fire regions detected	Classification	Fire regions marked	Fire regions marked	Success
5	Alert system	Alert about SMS	SMS alert	SMS alert	Success

- **CONCLUSION**

In this article, we firstly proposed ATT Squeeze U-Net for segmentation and recognition. The incorporated SqueezeNet architecture with modified Fire module on ATT U-Net, which enabled more effective feature learning based on limited data. Subsequently, another recognition model adopting a portion of the newly established encoding path was utilized for classification. Apart from providing existing segmentation and recognition frameworks with a more efficient alternative, this study also verified its effectiveness on fire recognition where high sensitivity was required and limited training data could be obtained. Experiments showed that the proposed architecture achieved relatively competitive segmentation accuracy and reliable recognition. However, there might still be some limitations in terms of comprehensive fire detection even though relatively accurate fire circumstances were alarmed and fire regions could be segmented in precise detail.

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