HBRP PUBLICATION

Research and Applications: Embedded System
Volume 2 Issue 3
DOI: [To be assigned]

A Review on Forest Fire Detection

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ABSTRACT
Forest are considered as one of the most important and indispensable resources. The common hazards in forest are forest fire. It causes great harm to the forest and result a very serious economic loss. In order to prevent the natural resources and human safety and property. Early detection in forest fire can be significant impact on the control of forest fire. Many forest fire detection techniques have been proposed by different researchers. There are so many techniques to detect the occurrence of forest fire. A fire detection method for the application of UAV-based forest fire surveillance using IR camera. This approach improves the accuracy and reliability of forest fire detection. This paper presents a literature study on forest fire detection.

Keywords: *Forest fire detection, UAV based forest fire surveillance*

INTRODUCTION

Forests are the protectors of earth's ecological balance. Forest fires can potentially result in a great number of environmental disasters, causing vast economic and ecological losses as well as endangering human lives. In order to preserve natural resources and protect human safety and properties, forest fire monitoring and detection have become a significant solution, which attract an increasing interest around the world. Especially, the growth number of large scale worldwide forest fires has made automatic fire detection as an important technique for the early fire alarm. Unfortunately, the forest fire is usually observed when it has already spread over a large area of forest, making fire control and stoppage is very difficult and impossible. The result is devastating loss and irreparable damage to the environment and atmosphere (30% of carbon dioxide (CO_2) in the atmosphere comes from forest fires), in addition to irreparable weaken the ecology. Among other dreadful consequences of forest fires are long-term calamitous effects such as impacts on local weather patterns and global warming. The difficulty with forest fires is that the forests are generally remote, unmanaged zones filled with trees, dry and dehydrating wood, leaves, and so into view that act as a fuel source. These elements form a highly inflammable material and represent the perfect context for initial-fire ignition and act as fuel for later stages of the fire. The fire ignition may be caused through human actions like smoking or barbeque parties or by natural reasons such as high temperature in a hot summer day or a broken glass working as a collective lens focusing the sun light on a small spot for a length of time thus leading to fire-ignition. Once ignition starts, inflammable material may easily fuel to feed the fires central spot then which becomes bigger and it spread easily. The initial stage of ignition is normally mentioned as "surface fire" stage. This may then lead to feeding on adjoining tree sand the fire flame becomes higher and higher, thus becoming "crown fire." Mostly, at this stage, the fire become sun

controllable and damage to the landscape may become excessive and could last for a very long time depending on prevailing weather conditions and the terrain. The very huge area of forest is destroyed by fire every year. Monitoring of the potential risk is sand an early detection of fire can significantly shorten the reaction time and also reduce the potential damage as well as the cost of firefighting. Known rule supply here: 1minute—1cup of water, 2 minutes—100litre of water, 10minutes—1, 000litres of water. The objective is to detect the fire as fast as possible and its exact localization and early informing to the fire units is crucial. This is the deficiency that the present Invention attempts to remedy, by early stage, so as to enhance or ensure the chance to put it out before it has grown beyond control or causes any significant damage. There are a number of detection and monitoring systems used by authorities. These include observers in the form of monitoring towers, satellite monitoring and increasingly encourage detection and monitoring systems based on optical camera sensors, and dissimilar types of detection sensors or their combination.

RESEARCH PAPERS RELATED TO FOREST-FIRE DETECTION

Jorge Moragues, Ignacio Bosch, Luis Vergara [1] - This paper describes a scheme for automatic forest surveillance. An absolute system for forest fire detection is firstly presented although we focus on infrared image processing. Each infrared image corelated to a pixel matrix and each pixel is related with a resolution cell which is located by means of its azimuth and range coordinates. First estimation the difficulty of automatic alarms detection, possibly to decide the presence of fire, in one resolution cell, once the energy level of the pixel in test reaches a particular threshold. If the statistic distribution of the noise is well known, the threshold can be used to satisfy a desired probability of false alarm (PFA), getting a probability of detection (PD) that depends on the signal to noise ratio (SNR). The captured images are processed by pixel to pixel. The invented scheme based on infrared image processing performs early detection of any fire threat. With the goal of finding the presence or absence of fire, in the algorithms implements the fusion of diverse detectors which exploit different anticipated features of a real fire, like tenacity and increase. Theoretical results and practical stimulations are conforming to control of the system related with probability of false alarm. Probability of detection (PD) is dependent on signal to noise ratio (SNR) is also calculated. We can take benefit of this extra statistics about infrared background noise to increase the SNR using a noise predictor. The estimated level may be subtracted from the pixel under test, thus improving SNR. Note that if we improve the SNR we get a better PD for a given PFA. The scheme based on infrared image processing performs early detection of any fire threat. With the purpose of determining the presence or absence of fire, the suggested algorithms execute the fusion of diverse detectors which exploit different predictable features of a real fire, like determination and increase. Theoretical results and practical simulations are presented to conform the control of the system related to probability of false alarm (PFA). Possibility of detection (PD) dependence on signal to noise ratio (SNR) is also estimated.

J. Xiao, Jie Li, Junguo Zhang [2] Certain fire automatic monitoring alarm and control functions are required in modern forest fire prevention facilities because of the characteristics of sudden, stochastic in forest fire, which make it difficult to fulfil the real-time monitoring. In recent years, the remote monitoring system based on network video camera provides reliable technical support for the real-time

monitoring. It is comprised of monitoring management command center, wireless transmission, vidicon, lens, and console control and power supply system. The fire identification with the digital image processing can greatly improve the technological content and the automation level of the fire detection system. In the light of the difficult of monitoring forest fire, the design plan and practical application of establishing the fire monitoring system founded on digital image facts are invented. The system is based on the continuous image captured by CCD camera. The configuration features, dynamic features and color information of that interesting region of fire with an application of the digital image processing algorithm, and then to recognize the fire cause according to the attained features. The experimental output show that the system can accurately identify and confirm the fire C. Yuan [3] - In this paper, an unmanned aerial vehicle (UAV) based forest fire detection and tracking method is proposed. Firstly, A UAV-based forest fire detection and tracking system is presented first. Most of the early researches detect fire by videos, and then researchers gradually use cameras to do fire detection in the real situation. Vision-based fire detection usually makes use of three dominant features of fire: color, motion, and geometry. Variety of vision-based methods primarily depends on image processing algorithms. In order to achieve the goals of automatic forest fire detection and tracking, this paper conducts a preliminary research on developing a set of image processing algorithms that is capable of effectively detecting and tracking forest fire. The basic idea of the proposed method is to adopt the channel "a" in Lab colour model to extract fire-pixels by making use of chromatic features of fire.

Wen-Bing Hang, Jim-wen peg [4] - Fire flame detection is an important issue because it closely related to every people's safety and property. The frequently used flame detection methods are based on particle sampling, temperature sampling, and air transparency testing, to the traditional ultraviolet and infrared flame detectors. However, most of these detectors suffer from some serious problems. They require a close proximity to the flame. In this paper, a new visual real-time flame detection method is proposed based on, machine vision techniques and the theory of chromatics to meet the above requirements. The intuitive HSI colour model is chosen to describe flame features extracted from a set of flame images. The colour separation method is applied to roughly segment regions with fire-like colours based on the extracted flame features. Then, the image difference method and the invented colour masking technique based on chromatics are used to remove spurious fire-like regions, such as objects with similar fire colours or areas reflected from fire flames. They have developed the rules for brighter and darker environments. After segmenting the fire region based on HSI rules the lower intensity and lower saturation pixels are removed to avoid fire aliases (fire like region). They also formed a metric based on binary counter difference images to measure the burning degree of fire flames such as no fire, small, medium, and big fires. Their result includes false positives and false negatives. But there is no way to reduce the false positives and false negatives by changing their threshold value. The experimental results show that the proposed method can achieve approximately 97% detection rate on average with thirty frames per second. In addition, the method can recognize fire flames within one second from the test videos, which seems very promising.

Turgay, Hasan Demirel [5]-In this paper, a rule-based generic colour model for flame

pixel classification is proposed. The proposed method is use the yCbCr colour space to construct a generic chrominance method for flame pixel classification. In addition to translating the rules developed in the RGB and normalized Rgb to YCbCr colour space, new rules are developed in YCbCr colour space which further alleviate the harmful effects of changing illumination and improves detection performance. The flame pixel classification rates of the proposed system with new rules and new generic chrominance model is compared with the previously introduced flame pixel classification model. This method segments the flame region except the flame center. But this proposed model gives 99.0% correct flame pixel classification rate with a method classifies fix pixels only based on colour information. 31.5% false alarm rate. This is a significant improvement over other method used in the literature.

J. Zhao, Z. Zhang, S. Han, Z. Yuan [6] - Different with the other kinds of fire surveillances, forest fire monitoring has its own properties. The cameras are placed on the top of mountains, and they are not stable because of wind. Focal length of the cameras is changeable, and the size of objects in recorded images is not constant. Most of the researched papers based on detection of fire detection. All of them have caused a great deal of problem for vision based fire detection, therefore it is necessary to specially study the case of forest fire recognition. In this proposed forest fire detection algorithm considers static and dynamic features subsequently. Support vector machine (SVM) trained with static features of the extracted from Gaussian mixture model was used. Fire was detected with good success but still had a problem with false positives when red objects are on the analysed image.

T.Qiu ,Y.Yan, G.Lu [7] - several method for edge-detection have been used to assess their success in flame edge identification. Despite the adjustment of many parameters in the use of this methods. Edges take out from non-trivial images are frequently inhibited by fragmentation, denotation that the edge curves are not connected, edge segments are false edges that do not resemble to notable phenomena in the image are shown. It is desirable to develop an edge detection method for flame and fire image processing.

D.Y. Chino, L.P. Avalhais, A.J. Traina [8] Emergency situations can cause economic losses, environmental disasters or serious damage to human life Existing solutions are based on ultraviolet and infrared sensors, and usually explore the chemical properties of fire and smoke in particle sampling. In this proposed method to detect fire in images captured by camera, without information, using visual features extracted from the captured images. To overcome the problems a fore mentioned, we propose a new method to detect fire in still images that is based on the combination of two approaches: pixel-colour classification and texture classification. The use of fire traces present particular textures that permit to differentiate between actual fire and fired regions. Even the information present in the images, it is possible to get a high accuracy level in the detection. The main contribution of this paper is BoW Fire (Best of both Worlds Fire detection), a novel method to detect fire in still images. By merging colour and texture information, our method showed to be effective in detecting true-positive regions of fire in real-scenario images, while discarding a considerable quantity of false-positives. Our method uses fewer parameters than former works, what leads to a more intuitive process of fine tuning the automated detection.

K.Angayarkkani, N. Radhakrishnan [9]- Forest fires are a chief environmental concern, causing economic and ecological damage while endangering human lives across the world. In this paper presents an system to detect the presence of forest fires in the forest using Artificial Neural Network(ANN). The digital images of the forest fire are converted from RGB to XYZ color space and then segmented by using anisotropic diffusion to identify the fire zones. Radial Basis Function Neural Network is used in the design of the intelligent system, the color space values of the segmented fire regions.

T.celik, H.demirel, H.ozkaramanli [10] - An algorithm is proposed which combines color information of fire with temporal changes in video sequences. Number of rules using normalized value in order to avoid the effect of changing illumination. In this method statistical analysis is carried out in rg, rb and gb planes.in each plane lines are used to specify a triangular region representing the region of interest for this pixel. A pixel is declared as fire pixel if it falls in to the triangular region of rg, rb and gb planes. The normalized RGB color space overcome the effects of variation in illumination to extent further improvement can be achieves by YCbCr color space with separate illumination from chrominance.

EXISTING WORK

Sensors

Nowadays almost all the fire detection system uses sensors. The accuracy, reliability and positional distributions of the sensor determine the betterment of the system. For high accuracy fire detection systems, large numbers of sensors are require in the case of open-air applications. Sensors also need a recurrent battery charge which is not possible in a large open space. Sensors are detected fire if it is close to fire. This will lead to damaging of sensor. These days, two different types of sensor networks are offered for fire detection, camera surveillance and wireless sensor network. The development of sensors, digital camera, image processing, and industrial computers resulted in the development of the modern technology system for optical, automated early recognition and warning of forest fires. Different types of detection sensors can be used in terrestrial systems.

1. video-camera, responsive to visible spectrum of smoke noticeable during the day and a fire recognizable at night,
2. Infrared (IR), thermal imaging cameras based on the detection of heat flow of the fire,
3. IR spectrometers to identify the spectral characteristics of smoke,
4. Light detection and ranging systems—LIDAR (detection of light and range) that compute laser rays reflected from the smoke particles. The variant optical

Systems working according to different algorithms planed by the builds, all have the same general concept in smoke and fire glow detection. Simply, the camera produces image severs while. The image consists of a number of pixels, where the processing unit tracks the motion in images and check show many pixels contain smoke or fire glow and then the processing unit sends the results for another algorithm to decide whether or not to produce an alarm for the operator.

Computer Vision Based Systems

These replace conventional fire detection systems, due to the rapid development of digital camera technology and video processing. Computer vision based systems use three stages.

1. Flame pixel classification.
2. Segmentation of moving object.
3. Analysis of the candidate region.

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The performance of the fire detection system depends on the performance of the fire pixel classifier which generates major areas on which rest of the system operates. Thus a precise fire pixel classifier is needed with high true detection rate and less false detection rate. A video flame detection algorithm, which initially applies background subtraction and color analysis to identify candidate flame region on the video frame and subsequently distinguishes between fire and non-fire object based on a set of fire extracted features including color probability. Spatial variation, temporal variation, spatial temporal variation and contour variability of candidate blob regions, however there exist some algorithms which directly deal with fire pixel classification. The fire pixel classification can be considered in both in gray scale and color video sequence.

CCD Cameras

Low cast CCD cameras are used to detect fires in the long range passenger aircraft. This method employs statistical features mean, standard deviation and second order moments along with the non-image features such as humidity and temperature. The system can also be used in smoke detector to reduce the false alarm. The system also provides visual inspection capability to confirm the presence or the absence of fire for the aircraft crew. Thermal camera or pan tilt zoom cameras can be added to the system. EYEfi does not offer automatic detection of smoke but plans to introduce it sometime in the near future. Simply, EYEfi can provide images for fire agencies whenever the operator notices smoke and can use EYEfi software to use the GIS map and locate the smoke position on the ground. A weather station and lightening detector are included in the system for more accuracy.

UAV-Based System

Owing to the development of modern technologies, more advanced forest fire detection approaches integrating remote sensing techniques with various platforms (such as satellites, ground-based equipment's, and aircrafts) are designed to overcome drawbacks of traditional methods. Particularly, due to their rapid maneuverability and improved personnel safety, there is an increasing demand to make unmanned aerial vehicles (UAVs) has been devoted to the application of UAVs for forest fire monitoring and detection. A typical UAV-based forest fire surveillance system is illustrated in below figure. Which is composed of a team of UAVs, different kinds of onboard sensors, and a central ground station? The goals are to take advantages of UAVs to detect and track fires, predict their propagation, and supply real time fire information to human firefighters and even to execute fire extinguishment with UAVs. The system can fulfil the missions of fire monitoring (search a potential fire), detection (find potential fire and produce fire alarm to firefighting staff), diagnosis (compute parameters of the fire position, extent and evolution), and prognosis (predict the fire propagation).

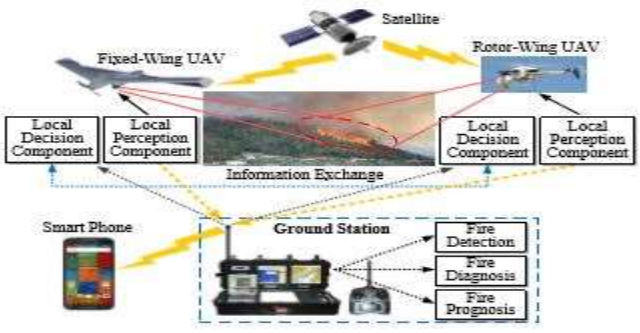

Fig.1: *Schematic Illustration of the UAV Based Forest Fire Surveillance System.*

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Forest fire monitoring is to find the possible occurrence of fire before it has appeared, while fire detection is to confirm whether there is a real fire in progress. Fire diagnosis is for the purpose of finding detailed data of fire. Fire prognosis aims to track and predict the fire propagation based on real time information of weather, vegetation composition of forest and fire parameter as powerful tools for operational fire-fighting. Recent decades, growing efforts In order to complete the above-mentioned tasks with minimum interference of human operators, the specific activities are the development of 1) UAV frames (fixed wing and rotary-wing types) carrying the necessary payload (remote sensing sensors for day-time, night-time, and all weather conditions) for fire detection and surveillance; 2) Remote sensing technologies for fires monitoring and detection; 3) Sensors fusion and image processing methods for quick fire detection, decision-making, and localization; 4) Guidance, navigation, control (GNC) algorithms for single UAV and multiple UAVs for monitoring, detection, tracking and prediction of fire development, and fire extinguishing operations; 5) Helpful localization, deployment, and control tactics of UAVs for ideal coverage of fire areas for accurate and rapid fire tracking, prediction, and support/guidance of firefighting; 6) Autonomous and reliable path planning and re-planning strategies before and after fire being detected based on the fire development situations; 7) Ground station which includes satellite and wireless communications, ground computation, visualization for fire detection, image processing, tracking and forecast with automatic fire alarm and for safe and efficient operation of UAVs systems during the entire mission.

It can be seen that the computer vision based fire detection technique is one of the most important elements in the UAV-based forest fire detection system. This is due to its numerous merits such as monitoring wide range object, offering intuitive and real-time images and recording information conveniently. More specifically, charge-coupled device (CCD) cameras and infrared (IR) cameras are usually mounted on UAVs. Massive efforts have been dedicated to the development of more effective image processing scheme for fire detection. The color and motion features in visual images captured by CCD cameras are mostly utilized for fire detection. However, the usage of CCD cameras is normally considered as not robust and reliable enough in some outdoor applications. Given highly sophisticated, non-structured environments of forest, the chance of smoke blocking the fire, or the situation for analogues of fire including reddish leaves swaying in the wind and reflections of lights, false fire alarm rate often tends to be considerably high. Due to the fact that IR images can be obtained in either weak or no light situations, and smoke can be seen as transparent in IR images, IR cameras are widely applied to capture monochrome images in both daytime and nighttime, even though IR camera is more expensive than CCD camera. By employing this effective solution it is expected to significantly reduce false fire alarm rate and enhance adaptive capabilities of the forest fire detection system in various environments.

CONCLUSION

Forest fires can potentially result in a great number of environmental disasters, causing vast economic and ecological losses as well as endangering human lives. In order to preserve natural resources and protect human safety and properties, UAV based forest fire monitoring and detection have become a significant solution, which attract an increasing interest around the world. This approach takes advantages of both brightness and motion features of fire

in IR images to improve the accuracy and reliability of forest fire detection. The invented system achieves 99.4% fire detection rate and 12% false detection rate. The invented method was compared with other methods in the literature and demonstrates superior performance in terms of higher fire detection rate and less false alarm rate.

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