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Video Surveillance based Fire Detection Approach – A Survey

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Abstract : Fire is a naturally destructive force that is highly useful if it is used in a controlled manner in various applications. Uncontrolled accidental or forest fire has the ability to cause massive damage and wreak havoc on property and life. The fire has the potential to destroy massive amounts of the forest as well as structures which can lead to loss of life and property on a very large scale. The conventional approaches for fire detection are highly limiting and expensive to implement as they require specified sensors. Therefore the detection of fire through image processing approaches is a novel breakthrough and where are researches regarding this topic have been discussed in detail in this survey paper. These approaches have been instrumental in designing our approach for the purpose of fire detection through analysis of the color of the fire the shape and the motion through temporal analysis. The implementation of the machine learning approach in the form of a decision tree also bolsters this methodology which will be elaborated further in the upcoming editions of this research.

Keywords - Fire detection, Image Morphology, Binarization, Decision Tree.

I. INTRODUCTION

Fire is one of the most influential and highly useful discoveries by humans. The fire was an accidental discovery that led to a lot of inventions and other improvements in the Lifestyle of humans over the years. Fire is highly useful for the purpose of cooking food which improves the flavor as well as unlocks the nutrients from the food which makes it a lot more nutritious and easy to digest. Fire is essential for the purpose of providing energy in the form of energy reactors and electricity generators which utilized fire or heat in some form or the other to produce energy or electricity. Fire is also produced in the hearts of engines and other internal combustion-based devices to provide propulsion which is used for transportation and other useful implementation.

The fire has been one of the most valuable resource that provided the early man with shelter and also provided light and warmth in the nights. The fire was useful for the purpose of tenderizing the food and making it easily digested and unlocking the nutrients in the food. Therefore fire is a highly important and useful phenomenon that is been reaping the benefits across the ages. Fire is allowed humans to prosper and grow and led to the industrial age as we know it now. The use of fire and combustion has been the very crux of the growth and improvements that were introduced at that time that are still being used to this day.

This steam age was instrumental through the implementation of the steam engine which propelled the entire society forward and leads to various discoveries and inventions eventually. Therefore fire is an essential requirement for growth and technological advancements. In internal combustion engines, the fire is another form of heat or energy that is highly useful in a controlled manner. These fires are essential as they are used to perform useful work with very high efficiency.

For this purpose various fossil fuels are burned to create propulsion that is effectively utilized to power machinery in the factories and the vehicles that are used to travel and transport goods. The discovery of fire has been effective in the realization of a

variety of technological advancements and bringing about the industrial age as the use progressed to achieve effective utilization of the resources.

Destruction of controlled fire and the uncontrolled fire is important as fire contains an enormous amount of energy which can be highly destructive if not controlled properly. This property of fire makes it highly problematic to deal with situations and other problems that can turn highly devastating once it loses control. These are the types of fires that are forest fires or wildfires along with accidental fires that can Wreak havoc and cause massive destruction of property and life. The fires consume everything that comes in their path and reduced them to smoldering rubble. Forest fires have the potential on destroying wildlife and other reserves which can be extremely damaging to the environment on a large scale.

There have been multiple wildfires in the recent years that have destroyed large tracts of land which included rich forests and wildlife that is exclusive to the place. The fire has resulted in largescale loss of biodiversity that is a very big loss to the entire planet and the human race. These fires have also resulted in the deterioration of the environment that has led to the increase in the amount of Greenhouse gasses as a byproduct of combustion of large amount of vegetation. These greenhouse gasses are increasing the temperature of the earth significantly and by a large margin. If these fires were effectively identified in time, it could have been nipped in the bud. Conventional fire detection approaches are not up to the mark in this regard and are unable to identify a forest fire effectively before it's too late.

Therefore these types of fires can be controlled at an early stage if detected effectively. There are various approaches that are implemented for the detection of Fire and most of these detection techniques utilize specific sensors and other hardware and equipment that have limited range and Limited applications.

The breakthrough in fire detection through the use of image processing approaches that can cover a large area and also has the ability to detect fire at a very early stage. For this purpose, the various approaches have been identified for the purpose of fire detection through image processing and have been elaborated in the survey paper.

II. LITERATURE SURVEY

Z. Jiao explains that forest fire or Wildfire can cause a lot of destruction and is one of the most damaging natural disasters. The forest fires are detrimental to the environment as well as these fires can be highly dangerous to the wildlife and the individuals in its path [1]. Therefore these wildfires must be detected early and utilized before they become a big problem. For this purpose, the authors in this approach have proposed the use of an unmanned aerial vehicle to provide surveillance and a real-time learning strategy based on the Yolo V3 algorithm.

K. Chen expresses that there are various techniques for the purpose of detection and identification of a fire in an indoor and outdoor environment. These techniques concentrate on the sensors and other detectors such a smoke detectors for the purpose of identification of the Fire. There are certain limitations with these approaches as they cannot be implemented in conditions that involve dust and sensors also required a monitoring space [2]. To overcome these problems authors in this approach have proposed the use of image processing techniques for the purpose of fire detection through the utilization of support vector machines.

S. Lei states that the paradigm of fire detection through the use of video input is a very novel technique that is still in its nascence. The detection of fire through the use of video is a highly convenient approach that can have very high accuracy [3]. Therefore the authors in this paper have proposed an effective technique that utilizes RGB-HIS color mode for the purpose of detection of fire in a video input. This approach has been effectively quantified through the use of extensive experimentation. This experimentation has been effective in realizing the performance of this approach which has been satisfactory and the fire has been detected along with the warning correctly.

X. Xu narrates that there has been an increase in the number of fires that happen in kitchens all across the globe. The kitchen is a very vulnerable fire hazard as there are heat sources and other utensils that are at high temperatures. These items can readily transfer heat to two other objects and can quickly reach the ignition point where a fire can occur [4]. Therefore there should be a technique for the realization of a fire detection approach that is customized for implementation in the kitchen. For this purpose, the authors in this approach have performed an extensive study on the various different scenarios that can lead to a kitchen fire. These approaches and scenarios have been instrumental in identifying the various methods through which a fire can occur.

X. Xiang explains that there are various different techniques that have been utilized for the purpose of extracting color information from an image. There is a lot of different models that have been implemented for the purpose of color extraction or color space identification of an image [5]. But most of these models are trade-offs or have some drawbacks that need to be addressed effectively. Therefore the authors in this approach have proposed the use of LUV color space for the purpose of optical flow computation.

O. Giandi expresses that technological advancements have only one reason and one goal that is to make the lives of individuals easier and a lot more convenient. These are the main goals that guide improvements in various sectors across the world [6]. Therefore there is also a need for an effective and easy to use fire symptom detection system that can be implemented without any hassles or inconveniences. Therefore the authors in this paper have proposed the use of various sensors to detect the gasoline concentration and predict the source of the Fire. This will allow the prediction of a gas leak concentration which can alert the user about the fire through an alarm before it can become destructive.

D. Pritam introduces the dangers of fires that can be a very damaging threat to property and life. Any fire has the potential to negatively affect the environment as well as the individuals around which can also lead to various fatalities and widespread destruction [7]. The Fire also has the potential to grow and further increase the destruction and damage in a larger form. Therefore there is a need for an effective and useful technique for the detection of Fire through the use of image processing algorithms for which the authors have proposed an effective technique that utilizes the LUV color space.

S. Li explains that there are various techniques that are used for the production of damage caused by fires. Fires are one of the most destructive forces of nature on this planet which can cause massive amounts of damage and destruction to property as well as life. Therefore the fires must be contained and effectively neutralized before they turn destructive and difficult to control. For this purpose, the authors in this Publication have proposed the use of water mist in extinguishing bus fires [8].

S. Wu discusses the problems that are identified or encountered when detecting fire through the use of image processing approaches and object detection algorithms. The authors identified the problems that are plaguing image processing-based fire detection techniques such as false positives late detection of the Fire and implementation of a real-time approach. The authors solve this problem through the use of yolo R CNN and SSD [9]. These are some of the most renowned object detection algorithms that are used in various applications and various fields for image processing implementation. The authors have studied the various differences and produced a highly reliable and real-time monitoring system for forest safety against fires.

III. PROPOSED METHODOLOGY

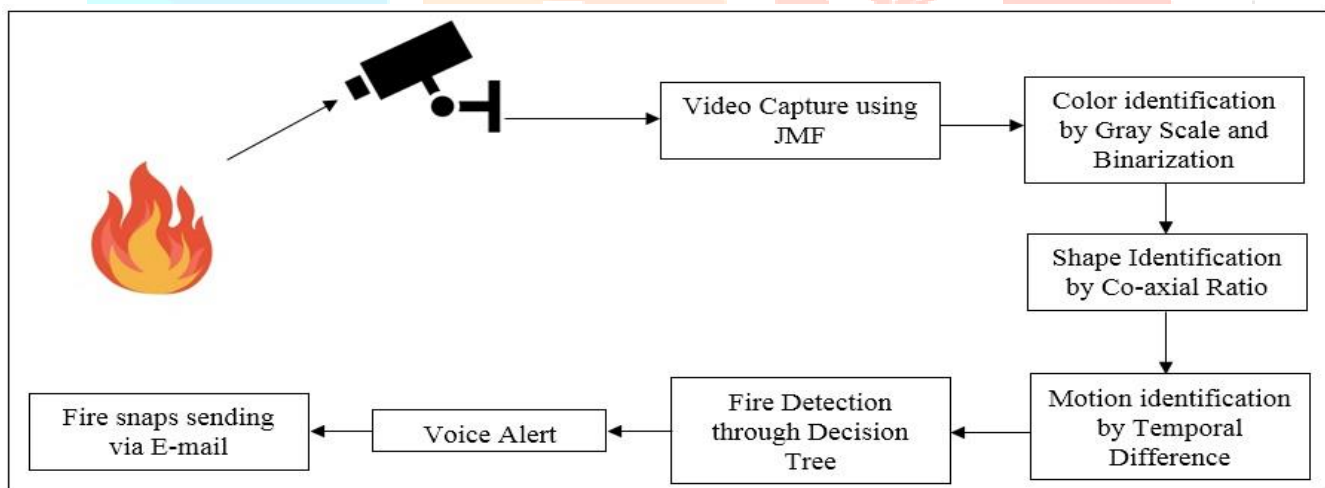


Figure 1: System Overview

The proposed system designed for the purpose of fire detection through the use of Shape, color, and motion is given in the figure 1 above. The video of the harmful fire is taken as an input and the system identifies it and sends an alert to the user.

The captured video from the CCTV or surveillance cameras is streamed live to the system. The JMF or the Java Media Framework is utilized to take the video as an input to the system. The video is streamed to the system which effectively extracts the frames from the video for further processing. The frames are extracted at a specific interval and are resized as a larger image would be highly computationally taxing.

The resized images are then provided for the purpose of identification of the fire in the image. The images are then subjected to binarization that identifies the region of fire in the image. The region of the fire is very bright and incandescent, this region is colored white and the background is colored black to obtain a grayscale image with the fire highlighted. The next step is the identification of the shape of the fire, for this purpose the co-axial ratio is implemented. The shape is then utilized to identify if there is any movement of the fire in the subsequent steps. The movement is identified through the calculation of the temporal difference between the frames that are extracted. The machine learning approach is integrated into this system through the use of Decision Tree. This approach will be elaborated further in the upcoming editions of this research.

IV. CONCLUSION

The paradigm of irritation has not been effectively improved over the past few years. Fires are highly devastating and can cause increasing amounts of damage as the fire spreads and increases in volume. Therefore there is a need for an effective system that can be implemented for the reduction of damage caused by fire through early detection and prevention methodologies through the use of image processing techniques. This paper analyses various researches performed on fire detection through image processing techniques which have helped in the formulation of our methodology. Are methodology implements fire detection through the analysis of fire by color identification image binarization shape identification and temporal analysis for extracting the motion of the Fire along with decision tree for classifying the fire and alerting the user. This approach will be further expanded in the upcoming editions of this research.

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