Real-Time Fire Detection for Video Surveillance Applications Using a Combination of Experts Based On Color, Shape and Motion

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Abstract- Fire causes irreversible damage to fragile natural ecosystems and greatly affects the socio-economic systems of many nations especially in the tropics where forest fires are more prevalent. Early detection of these fires may help reduce these impacts.

Conventional point smoke and fire detectors are widely used in buildings. They typically detect the presence of certain particles generated by smoke and fire by ionization or photometry. Alarm is not issued unless particles reach the sensors to activate them. Therefore, they cannot be used in open spaces and large covered areas. Video based fire detection systems can be useful to detect fire in large auditoriums, tunnels, atriums, etc. The strength of using video in fire detection makes it possible to serve large and open spaces. In addition, closed circuit television (CCTV) surveillance systems are currently installed in various public places monitoring indoors and outdoors. Such systems may gain an early fire detection capability with the use of fire detection software processing the outputs of CCTV cameras in real time.

Index Terms- Computer vision;Image processing; Real time detection; Fire detection; Notification system.

I. INTRODUCTION

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. Usually **Image Processing** system includes treating images as two dimensional signals while applying already set signal processing methods to them. t is among rapidly growing technologies today, with its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines too. The two types of methods used for Image Processing are Analog and Digital Image Processing. Analog or visual techniques of image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. The image processing is not just confined to area that has to be studied but on knowledge of analyst. Association is another important tool in image processing through visual techniques. So analysts apply a combination of personal knowledge and collateral data to image processing.

Digital Processing techniques help in manipulation of the digital images by using computers. As raw data from imaging sensors from satellite platform contains deficiencies. To get over such flaws and to get originality of information, it has to undergo various phases of processing. The three general phases that all types of data have to undergo while using digital technique are Pre- processing, enhancement and display, information extraction.

In the last years several methods have been proposed, with the aim to analyze the videos acquired by traditional video surveillance cameras and detect fires or smoke, and the current scientific effort focused on improving the robustness and performance of the proposed approaches, so as to make possible a commercial exploitation. Although a strict classification of the methods is not simple, two main classes can be distinguished, depending on the analyzed features: color based and motion based. The methods using the first kind of features are based on the consideration that a flame, under the assumption that it is generated by common combustibles as wood, plastic, paper or other, can be reliably characterized by its color, so that the evaluation of the color components (in RGB, YUV or any other color space) is adequately robust to identify the presence of flames. This simple idea inspires several recent methods: for instance, in fire pixels are recognized by an advanced background subtraction technique and a statistical RGB color model: a set of images have been used and a region of the color space has been experimentally identified, so that if a pixel belongs to this particular region, then it can be classified as fire. The introduction of the HSI color space significantly simplifies the definition of the rules for the designer, being more suitable for providing a people-oriented way of describing the color. A similar approach has been used in [6], where a cumulative fire matrix has been defined by combining RGB color and HSV saturation: in particular, starting from the assumption that the green component of the fire pixels has a wide range of changes if compared with red and blue ones, this method evaluates the spatial color variation in pixel values in order to distinguish non-fire moving objects from uncontrolled fires.

In this paper we propose a method able to detectfires by analyzing the videos acquired by surveillance cameras.Two main novelties have been introduced: first, complementary information, respectively based on color, shape variation and motion analysis, are combined by a multi expert system. The main advantage deriving from this approach lies in the fact that the overall performance of the system significantly increases with a relatively small effort made by designer. Second, a novel descriptor based on a bag-of-words approach has been proposed for representing motion. The proposed method has been tested on a very large dataset of fire videos acquired both in real environments and from the web. The obtained results confirm a consistent reduction in the number of false positives, without

paying in terms of accuracy or renouncing the possibility to run the system on embedded platforms.

II. EXISTING METHOD

In general, the use of flame detectors is restricted to "No Smoking" areas or anywhere where highly flammable mater1als are stored or used. Existing method followed the rules for filtering fire pixels in the HSI color space. This simple idea inspires several recent methods: for instance, fire pixels are recognized by an advanced background subtraction technique and a statistical RGB color model: a set of images have been used and a region of the color space has been experimentally identified, so that if a pixel belongs to this particular region, then it can be classified as fire.

The common limitation of the above mentioned approaches is that they are particularly sensitive to changes in brightness, so causing a high number of false positive due to the presence of shadows or to different tonalities of the red.

III. PROPOSED METHOD

Flame detectors are generally only used in high hazard areas such as fuel loading platforms, industrial process areas, hyperbaric chambers, high ceiling areas, and any other areas with atmospheres in which explosions or very rapid fires may occur. Flame detectors are "line of sight" devices as they must be able to see" the fire, and they are subject to being blocked by objects placed in front of them. However, the infrared type of flame detector has some capability for detecting radiation reflected from walls. In this paper we propose a method able to detect fires by analyzing the videos acquired by surveillance cameras. Two main novelties have been introduced: first, complementary information, respectively based on color, shape variation and motion analysis, are combined by a multi expert system. The main advantage deriving from this approach lies in the fact that the overall performance of the system significantly increases with a relatively small effort made by designer. Second, a novel descriptor based on a bag-of-words approach has been proposed for representing motion

IV. PROBLEM DEFINITION

The existing system uses only contrast based approach. It does not give efficient result. It takes long time identification and also the result is not accurate.

V. PROBLEM ANALYSIS

The purpose of the System Analysis is to produce the brief analysis task and also to establish complete information about the concept, behavior and other constraints such as performance measure and system optimization. The goal of System Analysis is to completely specify the technical details for the main concept in a concise and unambiguous manner.

VI. PACKAGES SELECTED

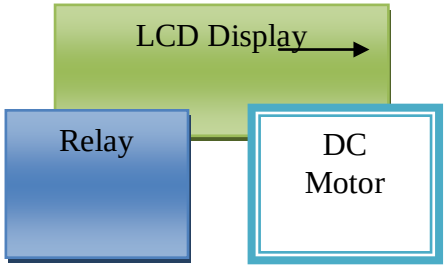
The package selected to develop watermarking is MATLAB and the package has more advanced features. As the system is to be developed in Watermarking, MATLAB platform with windows Application is preferred.

VII. FEATURES OF WINDOWS XP PROFESSIONAL

The ability to become part of a Windows Server domain, a group of computers that are remotely managed by one or more central servers. A sophisticated access control scheme that allows specific permissions on files to be granted to specific users under normal circumstances. However, users can use tools other than Windows Explorer (like cacls or File Manager), or restart to Safe Mode to modify access control lists. Remote Desktop server, which allows a PC to be operated by another Windows XP user over a local area network or the Internet. Offline Files and Folders, which allow the PC to automatically store a copy of files from another networked computer and work with them while disconnected from the network. Encrypting File System, which encrypts files stored on the computer's hard drive so they cannot be read by another user, even with physical access to the storage medium. Centralized administration features, including Group Policies, Automatic Software Installation and Maintenance, Roaming User Profiles, and Remote Installation Service (RIS). Support for two physical central processing units (CPU). (Because the number of CPU cores and Hyper-threading capabilities on modern CPUs are considered to be part of a single physical processor, multi core CPUs is supported using XP Home Edition.)Windows Management Instrumentation Console (WMIC): WMIC is a command-line tool designed to ease WMI information retrieval about a system by using simple keywords (aliases).

VIII. RESOURCES REQUIRED

In this phase it is necessary to analyze the availability of the resources that are required to design, develop, Implement and Test the project. The resources to be analyzed are Manpower, Time and the system Requirements. Teams of two members are involved in the entire SDLC life cycle except the testing phase. The testing phase is guided by the professional testers before the implementation of the product. Time Analyzed to complete the project is approximately four months with 4 hrs on daily basis except weekends. System requirements are analyzed and listed below.



IX. FEASIBLITY STUDY

The objective of feasibility study is not only to solve the problem but also to acquire a sense of its scope. During the study, the problem definition was crystallized and aspects of the problem to be included in the system are determined. Consequently benefits are estimated with greater accuracy at this stage. The key considerations are:

- ✓ Economic feasibility
- ✓ Technical feasibility
- ✓ Operational feasibility

Economic Feasibility

Economic feasibility studies not only the cost of hardware, software is included but also the benefits in the form of reduced costs are considered here. This project, if installed will certainly be beneficial since there will be reduction in manual work and increase in the speed of work.

Technical Feasibility

Technical feasibility evaluates the hardware requirements, software technology, available personnel etc., as per the requirements it provides sufficient memory to hold and process.

Operational Feasibility

This is the most important step of the feasibility study this study helps to predict the operational ability of the system that is being developed. This study also helps to analyze the approach towards which the system must be developed by which development effort is reduced. Proposed system is beneficial only if they can be turned into information systems, That will meet the organization requirements. This system supports in producing good results and reduces manual work. Only by spending time to evaluate the feasibility, do we reduce the chances from extreme embarrassments at larger stager of the project. Effort spend on a feasibility analysis that results in the cancellation of a proposed project is not a wasted effort

X. LITERATURE SURVEY

FIRE AND SMOKE DETECTION IN VIDEO WITH OPTIMAL MASS TRANSPORT BASED OPTICAL FLOW AND NEURAL NETWORKS
.Kolesov, P.Karasev, A.Tannenbaum . E.Haber

Detection of fire and smoke in video is of practical and theoretical interest. In this paper, we propose the use of optimal mass transport (OMT) optical flow as a low-dimensional descriptor of these complex processes. The detection process is posed as a supervised Bayesian classification problem with spatio-temporal neighborhoods of pixels;feature vectors are composed of OMT velocities and R,G,B color channels. The classifier is implemented as a single-hidden-layer neural network. Sample results show probability of pixels belonging to fire or smoke. In particular, the classifier successfully distinguishes between smoke and similarly colored white wall, as well as fire from a similarly colored background.

A Probabilistic Approach for Vision-Based Fire Detection in Videos Paulo Vinicius Koerich Borges, Member, IEEE, and Ebroul Izquierdo, Senior Member, IEEE

Automated fire detection is an active research topic in computer vision. In this paper, we propose and analyze a new method for identifying fire in videos. Computer vision-based fire detection algorithms are usually applied in closed-circuit television surveillance scenarios with controlled background. In contrast, the proposed method can be applied not only to surveillance but also to automatic video classification for retrieval of fire catastrophes in databases of newscast content. In the latter case, there are large variations in fire and background characteristics depending on the video instance. The proposed method analyzes the frame-to-frame changes of specific low-level features describing potential fire regions. These features are color, area size, surface coarseness, boundary roughness, and skewness within estimated fire regions. Because of flickering and random characteristics of fire, these features are powerful discriminants. The behavioural change of each one of these features is evaluated, and the results are then combined according to the Bayes classy- fier for robust fire recognition. In addition, a priori knowledge of fire events captured in videos is used to significantly improve the classification results. For edited newscast videos, the fire region is usually located in the center of the frames. This fact is used to model the probability of occurrence of fire as a function of the position. Experiments illustrated the applicability of the method.

Visual-based Smoke Detection using Support Vector Machine
Jing Yang, Feng Chen, Weidong Zhang

Smoke detection becomes more and more appealing because of its important application in fire protection. In this paper, we suggest some more universal features, such as the changing unevenness of density distribution and the changing irregularities of the contour of smoke. In order to integrate these features reasonably and gain a low generalization error rate, we propose a support vector machine based smoke detector. The feature set and the classifier can be used in various smoke cases contrary to the limited applications of other methods. Experimental results on different styles of smoke in different scenes show that the algorithm is reliable and effective.

Face Image Abstraction by Ford-Fulkerson Algorithm and Invariant Feature Descriptor for Human Identification Dakshina Ranjan Kisku Debanjan Chatterjee1 , S. Trivedy2 Massimo Tistarelli

—This paper discusses a face image abstraction method by using SIFT features and Ford-Fulkerson algorithm. Ford-Fulkerson algorithm is used to compute the maximum flow in a flow network drawn on SIFT features extracted from a face image. The idea is to obtain an augmenting path which is a path from the source vertex to destination vertex with the available capacities on all edges along a set of paths and flow is calculated along one of these paths. The process is repeated until it is obtained more paths with the available capacities. At the initial stage, face image is characterized by SIFT (Scale Invariant Feature Transform) features and the keypoints descriptor information is taken as features set for further processing.

Keypoints descriptor is used to generate several face representations by using a series of matrix operations which are further used to determine a Directed Acyclic Graph (DAG). The resultant directed graph contains sparse and distinctive face characteristics of a subject from which the face image is captured. We then apply the Ford-Fulkerson algorithm on the directed graph to maintain the capacity constraints, skew symmetry and flow conservation to obtain an augmenting path with available capacities (relation between SIFT points). Finally, we obtain a mathematical representation of a face image and this representation is further encoded to be used as a set of distinctive features for matching. The time complexity of the proposed face abstraction algorithm is found to be O(VE2) where V is the set of vertices and E is the set of edges in a directed graph.

Optical Flow Estimation for Flame Detection in Videos Martin Mueller, Member, IEEE, Peter Karasev, Member, IEEE, Ivan Kolesov, Member, IEEE, and Allen Tannenbaum, Fellow, IEEE

Computational vision-based flame detection has drawn significant attention in the past decade with camera surveillance systems becoming ubiquitous. Whereas many discriminating features, such as color, shape, texture, etc., have been employed in the literature, this paper proposes a set of motion features based on motion estimators. The key idea consists of exploiting the difference between the turbulent, fast, fire motion, and the structured, rigid motion of other objects. Since classical optical flow methods do not model the characteristics of fire motion (e.g., non-smoothness of motion, non-constancy of intensity), two optical flow methods are specifically designed for the fire detection task: optimal mass transport models fire with dynamic texture, while a data-driven optical flow scheme models saturated flames. Then, characteristic features related to the flow magnitudes and directions are computed from the flow fields to discriminate between fire and non-fire motion. The proposed features are tested on a large video database to demonstrate their practical usefulness. Moreover, a novel evaluation method is proposed by fire simulations that allow for a controlled environment to analyze parameter influences, such as flame saturation, spatial resolution, frame rate, and random noise

Detection of Multiple Dynamic Textures Using Feature Space Mapping Ashfaqur Rahman and Manzur Murshed, Member, IEEE

Image sequences of smoke, fire, etc. are known as dynamic textures. Research is mostly limited to characterization of single dynamic textures. In this paper we address the problem of detecting the presence of multiple dynamic textures in an image sequence by establishing a correspondence between the feature space of dynamic textures and that of their mixture in an image sequence. Accuracy of our proposed technique is both analytically and empirically established with detection experiments yielding 92.5% average accuracy on a diverse set of dynamic texture mixtures in synthetically generated as well as real-world image sequences.

Detection of Anomalous Events in Shipboard Video using Moving Object Segmentation and Tracking
Ben Wenger and Shreekanth Mandayam Patrick J. Violante and Kimberly J. Drake Anomalous indications in monitoring equipment onboard U.S. Navy vessels must be handled in a timely manner to prevent catastrophic system failure. The development of sensor data analysis techniques to assist a ship's crew in monitoring machinery and summon required ship-to-shore assistance is of considerable benefit to the Navy. In addition, the Navy has a large interest in the development of distance support technology in its ongoing efforts to reduce manning on ships. In this paper, we present algorithms for the detection of anomalous events that can be identified from the analysis of monochromatic stationary ship surveillance video streams. The specific anomalies that we have focused on are the presence and growth of smoke and fire events inside the frames of the video stream. The algorithm consists of the following steps. First, a foreground segmentation algorithm based on adaptive Gaussian mixture models is employed to detect the presence of motion in a scene. The algorithm is adapted to emphasize gray-level characteristics related to smoke and fire events in the frame. Next, shape discriminant features in the foreground are enhanced using morphological operations. Following this step, the anomalous indication is tracked between frames using Kalman filtering. Finally, gray level shape and motion features corresponding to the anomaly are subjected to principal component analysis and classified using a multilayer perceptron neural network. The algorithm is exercised on 68 video streams that include the presence of anomalous events (such as fire and smoke) and benign/nuisance events (such as humans walking the field of view). Initial results show that the algorithm is successful in detecting anomalies in video streams, and is suitable for application in shipboard environments. One of the principal advantages of this technique is that the method can be applied to monitor legacy shipboard systems and environments where highquality, color video may not be available.

XI. CONCLUSION

In this paper, we have proposed an efficient method to remove hazes from an image. Our method benefits much from an exploration on the inherent boundary constraint on the transmission function. This constraint, together with a weighted $L1$-norm based contextual regularization, is modeled into an optimization problem to recover the unknown transmission. An efficient algorithm using variable splitting is also proposed to solve the optimization problem. In comparison with the state-of-the-arts, our method can generate quite visually pleasing results with faithful color and finer image details and structures. Image dehazing often suffers from the problem of ambiguity between image color and depth. That is, a clean pixel may have the same color with a fog-contaminated pixel due to the effects of hazes. For example, some white objects in the scene often have a confusing color with the hazes. Therefore, without sufficient priors, these pixels are difficult to be reliably recognized as fog-contaminated or not fog-contaminated. This ambiguity, revealing the unconstraint nature of single image dehazing, often leads to excessive or inadequate enhancements on the scene objects. From a geometric perspective of image dehazing, we have derived a boundary constraint on the transmission from the radiance cube of an image. Although the boundary constraint imposes a much weak constraint on the dehazing process, it proves to be surprisingly effective for the dehazing of most

natural images, after combined with the contextual regularization. More generally, one can employ a tighter radiance envelop, not limited to a cubic shape, to provide a more accurate constraint on the transmissions. This may help to further reduce the ambiguity between color and depth, and avoid many erroneous enhancements on the image.

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