ICAFD: An Intelligent Computer Aided Fire Detection System for Surveillance Monitoring Systems

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Abstract— ***Fire accidents are one of the dangerous events occur at any time anywhere like research buildings, malls, forest and various industries. It makes lot of financial loss, sudden human deaths and huge amount of loss in things, whereas it affects the public. If the event is initially identified and detected then it helps to reduce the loss and provide security. Small fire event can be controlled and make only less loss. To do that a surveillance application is designed and implemented for generate the alarm whenever it detects a fire event. Immediate alarm can alert the people those who are very closure to the event location can protect themselves and they can take immediate actions. In this paper the video frames are pre-processed, segmented and classified using ICAFD (Intelligent Computer Aided Fire Detection) which comprises of Discrete Cosine Transformation (DCT) incorporated with Entropy method. This sequence of image processing methods is implemented and experimented in MATLAB software and the results are verified. The performance of the proposed approach is verified and evaluated by comparing with the earlier approaches. From the results it is identified that the proposed approach outperforms than the other approaches.***

I. INTRODUCTION

In recent days surveillance monitoring based applications has been growing continuously and there is an extra ordinary improvement in related video analysis applications. The main objective of the video analytics is to obtain the potential abnormal events without human intervention. One of the dominant research areas is video surveillance where it comprises of pattern, object, human activity recognition and classification as normal or abnormal. Identifying and locating the events in the video is generally a manual or semi-automatic application. A Manual surveillance system completely depending on the human being operation. It needs a human labour to identify, locate and analyse the behaviour of normal or abnormal activity in the events. The semi-automatic application requires a smaller number of human interventions to analyse the video. But a fully automatic system can perform intelligently and smartly without the help of any human to classify the normal and abnormal activities. The author in [5] described that various public, private, corporations and Government sectors are spending a huge amount of money for tightening the security to houses, infrastructure, offices, buildings, malls etc., and this trend is going to accelerate more in coming years of automatic security industry. Now a day's terrorism activities are exponentially increasing thus it is an essential purpose to identify and detect suspicious activities which are affecting normal human lives. Suspicious activities are the deviation of an object behaviour from normal behaviour where it shows the object in unusual place, moving in wrong direction, entering or existing from restricted area, wrong terms in traffic, fighting or violence among humans, left bag, people walking in different directions, sudden moment, dropping an object like any kind of unusual activities. In order to identify these kind of suspicious activities applications discussed in [1] developed for anomaly detections. The following applications [1] are used for anomaly detection in earlier research works as

- Traffic monitoring
- Medical Science
- Surveillance areas like Military area, Airport etc.,
- Crowd analysis
- Criminal activity recognition
- Automatic forensic video surveillance

Some of the potential applications [2] developed in earlier research works for suspicious activity detection are as,

- Intelligent transport management system
- Security alarm generation
- Surveillance in schools
- Surveillance in Care houses and
- Surveillance in Training Institutes.

Though the above applications are intelligently performing well it faces lot of challenges, as

- Object detection in normal video streaming is difficult
- Exact notion of abnormal behavior is either subjective or changes over different applications.
- Possibility of ambiguous boundary between normal or abnormal behavior.
- Presence of noise and tricky to label the behavior.

In order to solve the above challenges a great type of methodologies have been proposed. Two assumptions are taken to design method for abnormal activity detection system.

- Frequency of occurrence of abnormal activity is less than the normal activity in video.
- Similarity between normal and abnormal events is very less.

Most of the abnormal activity detection methods are classified as single layered or hierarchical methods. The hierarchical method is again classified into description based, syntax based and statistical based approach. Single

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layered methods are focused on modeling the human activities. Abnormal activity detection is carried out into two stages such as training the system with normal and abnormal activities, then it differentiates the testing acting activities by using the trained information. Second one is using the dominant set of properties through which the dominant behavior objects are classified as normal behavior and less dominant behavior are classified as abnormal behavior. Anomaly detection is applied by analyzing the moving pattern, appearance of the object and the dynamic behavior such as directions, speed, location and route of the moving objects. Appearance based anomaly detection focused on color, identity, texture, shape and posture of the objects. In this paper it is highly aimed to design and develop an Intelligent computer aided fire detection system for surveillance monitoring. This surveillance system can be deployed to monitor a forest, a medical industry, a building, mall and etc., to identify fire accidents and produce alert alarms to the administrator automatically. The proposed ICAFD system learn the input video, observes the objects and their activities initially. During the observation if it detects any fire activity then it produces the alert alarm. The entire contribution of the proposed ICAFD system is,

1. Designing the ICAFD system
2. Video into Frames
3. DCT and Entropy Based fire detection

II. BACKGROUND STUDY

To design and implement a new ICAFD system it is important to understand the issues and challenges of the earlier research works. This section presents a detailed literature review about various methods, approaches and techniques focused on abnormal identification in a video surveillance system. A set of all recent research works, for example various kinds of frameworks are proposed for identifying and detecting abnormal activities in surveillance video [3]. The framework used different methods in accordance to the different applications. For example, Author in [4] proposed a novel approach for abnormal activity detection based on the dominant behaviour of the objects, where the dominant set theory has been proposed by the author in [5], to identify and detect the abnormal activities of the object's presence in the video.

III. DATASET

To experiment the proposed method a set of fire videos and video sequences are taken from the benchmark dataset available at "https: //www. crcv.ucf.edu /data /fire.php", which is collected and copyright by the research department of University of Central Florida. It has a collection of 6 fire videos, which are already experimented and classified by the author in [6]. The play time of each video is about 3 minutes to 5 minutes. All the five videos are used in the experiment and the results are verified.

IV. PROPOSED DCT BLOCK BASED OBJECT DETECTION

A universal model is designed in accordance to the characteristics that are extorted straight from action likely speed at pixel-point. It will direct to the picture which articulates the action in the sequence. Later the data content of the picture is examined within the "incidence" area by means of calculating the entailed DCT (Discrete Coefficient Transform) coefficients which gets transmitted to the restricted action area. We must realize the performance of the objects, once the performance is effectively examined in every structure. The perceptive of action entails the examination and identification of event patterns, also its depiction at huge intensity in accordance to RED colour. To deem either happenings are usual or unusual related to its performance characteristics, it also evaluates every segment to the median standard rates across point in time to categorize the actions in order to know that they are usual and unusual. The need for an adaption of DCT concept is clearly illustrated in the real-time feature, while these could be proficiently executed.

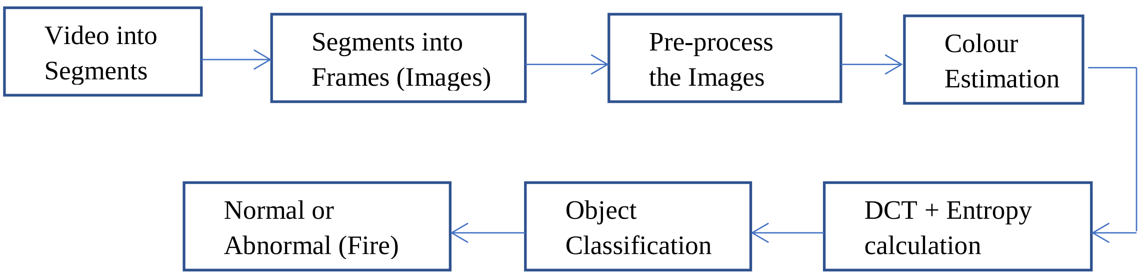

Figure-3: ICAFD for Surveillance Video

In accordance to event behaviour our unusual happenings are recognized and extorted by action evaluation method. Within a picture series the event inference aims by identifying the areas parallel to office, cars closely moving, office and etc. The characteristics are related to pixel-based optical flow, which is said to be one of the most normal methods for capturing the events. The computer vision specifies that the calculation of optical flow is not precise, epically upon noisy records. To overcome this drawback the optical flow utilizes Lucas-Kanade algorithm [7] in every structure. When the optical flow is related to action evaluation it utilizes the features of flow vectors of moving objects. Therefore, the dislocation of every pixel from image to image in every vector is presented evidently [8]. The dislocation rate of every pixel is the outcome of optical flow at both perpendicular also horizontal routes. To acquire action magnitude vector all the dislocation is joined.

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In order to routing out these motion vectors, the pixel rates are replaced for calculating the action, also every structure is partitioned into segments. During abnormal activities, the moving pattern and the energy of the objects are changed. Hence the motion vector of the image and objects is changed comparing with the normal activity. DCT is pertained in every segment, as it supplies a compressed presentation of the signal's force. Lastly, the DCT coefficients are calculated in order to compute the data structure [9]. The entropy is termed in [10]:

$$\boldsymbol{E = -\sum_{i=1}^{N} p \, log_p}$$

In which, **N** is the picture volume also **p** specifies the possibility of event power value at certain pixel position. In histogram the number of bins illustrates the kind of picture. Whereas a red-channel scale picture is formed when the size of the action is structured per pixel also 256 bins are utilized which might match up to the amount of red-channel heights. To identify either the action is usual or unusual; the entropy rate is contrasted with threshold rate which has been noticed earlier in video tapes. The acquired threshold is related to median rate of the entropies which is considered during the initial 500 frames of video. Apparently, we might imagine that the unusual event does not happen in the first set of 100 frames of video series. This procedure is processed regularly by video series as the unusual events are filtered with the help of the median rate.

The median filtering is restricted for some time in order to organize the entire intricacy of the computations. The unusual happening is specified when the present frame rate of the entropy is slightly higher than the threshold rate specified within the block. A different strategy [11] is utilized which identifies the static rate that depicts how efficiently the optical flow vector is structured within the framework. A metric is utilized in this algorithm which is nothing but the scalar result of the normalized rate and those features are: difference in route, difference in action level also the route of histogram. The acquired metric is contrasted with the threshold in order to place a regular value manually. In figure-3 the system model of a processed block procedure during the active sequence is depicted.

Each individual object is obtained after background subtraction in the earlier research works. Then the objects are compared using other objects are features of the objects in the ground truth images. But in this paper, to increase the accuracy, the DCT block-based object comparison without any disturbance the entropy values of the objects are compared. Since the entropy of the object represents various important information about the images and it is used here. In order to identify and show externally the abnormal objects in the image a boundary box is drawn on the image around the objects. Generally, the power within RGB colour space distinguishes every pixel. Finally, from the monitored rate of every pixel, the possibility is computed. For every connected element, the bounding boxes are founded, subsequent to individuals' action within the object "vision.BlobAnalysis". The areas of pixels that are connected in a picture are the recognitions of the blob analysis. The restriction of rectangle is created by following the events; the location of every static and moving objects is discovered throughout the events by utilizing the bounding box outcome (BBOX) and it can be obtained using the following Pseudo code.

V. PSEUDO CODE FOR BOUNDING BOX

$The\ size\ of\ the\ objects\ is\ defined\ as: x - width$
$and\ y - height$
$(x_0, y_0)\ is\ the\ upper\ left\ point\ of\ teh\ boundary\ box$
$x\ is\ minimum\ of\ X$
$y\ is\ minimum\ of\ Y$
$width = [x, y + H;\ X2 + L, y + H]$
$Height = [x, Y2; x, y + H]$
$H: height\ of\ the\ boundary\ box$
$W: Width\ of\ the\ boundary\ box$
$X2: is\ minimum\ of\ X$
$Y2:\ is\ minimum\ of\ Y$

VI. EXPERIMENTAL RESULTS

In this research work, the forest surveillance videos are utilized so that various unusual circumstances are replicated with the help of many volunteers. The unusual circumstances comprise of various volunteers, performing dances in various formations and also running and moving here and there sometimes might get overcrowded. Therefore, it has an overall six kinds of circumstances which take place in 12000 frames of video series. The usual screening quality for a video surveillance is 720 576 by 29 frames per second, which is the spatial motion of a novel video frame.

Figure-4: Video Frame Sequences

Moreover, a different strategy which is projected by the authors in [11] is contrasted with the presentation of this strategy and the resulted outcome is evaluated. Each frame is divided into four segments in our present research work, and it could be modified easily. The entropy of DCT coefficients is computed for every segment also the median rate for the first 500 frames is calculated. In relation to this research and analyse, to categorize the abnormal happenings for the threshold median entropy it is positioned to 3 times than the median rate. If there are any unusual happenings in any of the segment, in such cases an unusual indicator raises

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for the entire structure. Figure-4 represents the set of all frames extracted from a video short. The duration of the video short is 1minute.

Figure-5(a): Fire Detection in Video-1

Figure-5(b): Fire Detection Video-2

Figure-5(c): Fire Detection in Video -3

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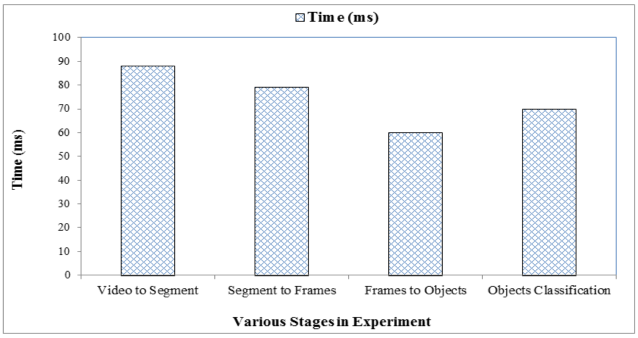

Figure-6: Time Complexity for various stages of the experiment

The number of frames extracted from video short is 95. Some of the frames are given in Figure-4. Initially all the images are considered as a normal image and the process started. In each frame, after object detection the entropy is calculated from the DCT values and compared with the threshold values already calculated and stored in a database from ground truth images. Ground truth images are suggested from programming experts. The abnormal fire event is identified from the sequence of input frames are shown in Figure-5(a) to Figure-5(c). The abnormal events are the fire events occurred in the video, which is shown in Fgure-5. The variation of the entropy and matching with the ground truth objects helps to classify the objects are normal or abnormal. The set of all normal and abnormal (Fire) events are identified using the ICAFD are shown in Figure-4 and in Figure-5 respectively.

Table-1: Performance Analysis in Terms of Classification Accuracy

Data	Classification Accuracy					Total	Accuracy (%)
Dataset (In frames)	200	400	600	800	1000	3000	
Correctly Classified	183	341	529	711	849	2613	87.1
Incorrectly Classified	17	59	71	89	151	387	14.81056

Also, the performance of the ICAFD approach is evaluated by computing the computational time complexity and accuracy in classification. To do that, time taken for video to segments, segment into frames, frames into objects and object classification is computed in the experiment and the obtained results is shown in Figure-6. The average time taken for the entire system model is 74.25 ms including all the stages. In terms of classification the accuracy is calculated and the obtained results are given in table-1. From the results it's clear that percentage of accuracy is 87.1%.

VII. CONCLUSIONS

In this research work, it is mainly motivated to identify unusual happenings in surveillance tape observed in public place. We had played a major role in establishing attributes which are very useful to actions also by utilizing a threshold which is mechanically modernized in order to recognize unusual happenings. The altered action size of DCT entropy determined is a consistent measure in order to categorize that the fire event in the video tape is usual or unusual one. Since the projected technique is block-based, we might accurately specify the component of the frame in which the unusual happenings occur. An additional benefit in utilization of block is that there is chance for parallel routing in real-time execution, as every block could be processed without any dependency. The forest, building surveillance video output is obtained by identifying abnormal happenings during the prevention of fake alarms. This structure need not depend upon the kind of view since it is common.

In future work, for identifying unusual happening, more exploration on DCT-related attributes is predicted. Moreover, we would like to test this strategy on special kinds of scenes which does not only engage fire also human activity and objects that are kept moving. From the obtained results the proposed approach is considered as better approach for fire detection and recognition.

Since the time complexity is more and accuracy is merely less it should be improved by computing the error models in the frames and the objects. Future work will be to take this approach and experiment and verify the results with more benchmark dataset and custom dataset and to integrate this and model along with a sophisticated framework that can be deployed for smart surveillance.

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