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Abnormal Crowd Detection and Tracking in Surveillance Video Sequences

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Abstract: We have proposed a method for abnormal crowd detection and tracking in this paper. Automated analysis of crowd activities using surveillance videos is an important issue for communal security, as it allows detection of dangerous crowds and where they are headed. Public places such as shopping centres and airports are monitored using closed circuit television in order to ensure normal operating conditions. Computer vision based crowd analysis algorithm can be divided into three groups; people counting, people tracking and crowd behaviour analysis. In this paper the behaviour understanding will be used for crowd behaviour analysis. The purpose of these methods could lead to a better understanding of crowd activities, improved design of the built environment and increased pedestrian safety. The experimental results show that the proposed method achieves good accuracy

Keywords: Background Modeling, Video Surveillance, Abnormal Crowd Detection, Crowd Tracking, Motion Analysis

I. INTRODUCTION

In many applications, such as video surveillance, content-based video coding, and human–computer interaction, moving object detection is an important and fundamental problem. The general technique for moving object detection is background elimination under the situation of fixed cameras. Detection of moving objects in video stream is the first related step of information removal in many computer visualization applications, including video surveillance, people tracking, traffic monitoring, and semantic annotation of videos. Video cameras are extensively used in surveillance application to examine public areas, such as train stations, airports and shopping centres. When crowds are intense, automatically tracking individuals becomes a difficult task. Anomaly detection is also known as outlier detection, which is applicable in a verity of application.

Our proposed frame work is to implement a new tracking technique. Human monitoring is tiring, expensive, and ineffective. Our approach is a real time contribution to abnormal event detection and uses the motion of computational attenuation which quantifies motion saliency. The proposed method can be applied from small group of objects to dense touching moving objects like crowed. Crowded environments are very complicated to monitor by human observer, whether live or by means of video surveillance, because the optical patterns are highly recurring and the difficulty of the movement characterize the scene is often overpowering. Crowd finding is particularly significant in the background of intellectual and automated video surveillance systems proposed for large venues and public events, such as football games and concerts, as well as for such general environments as City Street and underground train stations during pinnacle hours. A crowd element can be defined as a region related to more than one person who has logical and identical motion. Crowd movement tracking is quite dissimilar from tracking individuals in the crowd. When individuals are being tracked, the information is compute at the level of each individual. One purpose is to construct model of crowd performance and to detect irregular activities at the crowd level rather than at the individual level. Crowd analysis also finds applications in crowd simulation, crowd management, disaster management, outlet planning as well as other related areas. The purpose of this study is to analyse the crowd behaviour in real time in order to detect abnormalities that could lead to dangerous situations using computer vision and machine learning techniques. This paper is organised as follows; motivation and related works are discussed in section II. The proposed method of abnormal crowd detection and tracking is explored in section III. Experimental results are given in section 4 and conclusion is drawn in section 5.

II. MOTIVATION AND RELATED WORKS

The detailed literature survey of our work is presented in this section. Abnormality detection is classified into two categories; trajectory analysis and motion analysis. Trajectory analysis is based on object tracking and typically requires normal environment to operate. Motion analysis is better suitable for crowded scenes by analysing patterns of movement rather than attempting to distinguish object. Some of the few existing works consider the relationship between pedestrians' social behaviours and their walking scenarios. Recently, some methods [1], [2] utilize crowd flow and semantic scene knowledge to detect abnormal activity and obtained good results. But these methods can be only applied for some simple scene (e.g. single sink/source, single crowd flow). There have been attempts to model crowds based on discriminative classifiers [3].The analysis of crowd behaviour and movements are of particular attention in video surveillance domain [4].

In the circumstances where few operators are monitor behavioural analysis of crowds in hundreds of cameras is useful as a very tool for video pre-screening. Activity and event detection has got more concentration in automated

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video surveillance, content-understanding and content-ranking [5, 6]. Activity detection identifies the actions of a target based on a series of observations and interactions with the environment. To enrich the realistic characteristics, both contextual and social semantic effects should be considered in formulating the crowd behaviour. Inspired by the social behaviour modeling [7], people are forced by their destination and sensation which is powered by the communication of other people. Mehran et al. [8] adopt the social force model and particle advection scheme to the abnormal crowd activities by examining the interface force. Pellegrini et al. [9] propose a Linear Trajectory Avoidance (LTA) method to track multiple targets. Predictions of velocities are calculated by the minimization of energy potentials.

Recently, Mehran et al. [10] propose a method to model behaviours among a group of people. It represents the abnormal patterns in a local region based on moving particles. The detection of Object Put is based on dual-foreground algorithm where the divergence in response is analyzed. Based on over completes set of low-level spatio-temporal features and the mining of a dense a new technique for action recognition is implemented [11]. The tracking system is a basic blob tracker described in [12]. It is composed of two main components: (1) background modeling, and (2) track management. First, foreground/background segmentation is performed and then, objects are tracked with a combination of blob matching and particle filtering techniques. Ramin Mehran *et al* proposed a method to detect and focus abnormal activities in crowd videos using social force model. This paper is tested on publicly presented dataset of normal and abnormal crowd videos. The proposed method is confining the abnormal activities in contrast to use of optical flow [13].

Louis Kratz et al a proposed new statistical framework for modeling the local spatio-temporal motion pattern behaviour of extremely crowded scenes. Previous work in this paper of unusual event detection is classified into two categories; explicit and deviation methods. Deviation method is usual activity; it can detect the unusual events. Event detection approach model is each specific activity for identification in videos. The tracking-based model for extremely crowded scenes would also disregard the important correlation between pedestrians within close proximity of each other [14]. Hui Ma, et al, proposed a method is the robust descriptor for encoding the intrinsic local and global behaviour signatures in crowded scenes. The crowd scenes conversion from normal to abnormal behaviours such as rush and scatter were detected. This method is evaluating the other methods for anomaly detection in crowds with a very good detection accuracy rates. This report is not based on motion tracking.[15]. The future method a new tracker which employs a element filter tracking structure, where the state transition model is estimated by an optical-flow algorithm. The optical-flow algorithm is used to estimate the state transition. The optical-flow vector is more accurate than the fixed models. The proposed tracking method is better than the performance is largely improved compared with state of the art trackers. [16].

III. PROPOSED METHOD

Proposed method consists of three major modules: i.) Background Modeling, ii) Blob Analysis, iii) Crowd Detection and Tracking .The proposed method is explored in Fig.1. Input video we have taken from public datasets UMN.

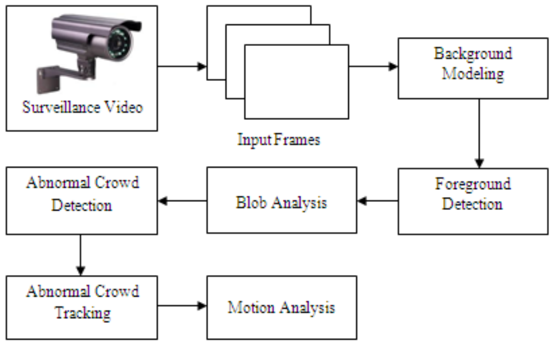

Fig.1. Block Diagram

A) Background Modeling

Background modeling is a very significant role in a video content analysis system. Background subtraction is the method used to fragment the object in a frame. When static cameras are used, a popular approach is background subtraction, which consists of obtaining a mathematical representation of the static background and comparing it with each new frame from the video sequence. A moving object can be detected easily by identifying parts of the image that do not match with the model. This process is known as background subtraction. It is groundwork for various post-processing modules such as object tracking, recognition, and counting. There are two types of background detection methods: non-adaptive and adaptive. Non-adaptive method depends on definite numbers of video frames and do not sustain a background model in the algorithm. Adaptive methods normally preserve a background model and the parameters of the background model vary over the time. A background model is learned by using Gaussian Mixture Models to represent the time-varying back- ground scene. It describes each pixel as mixture of Gaussian and updates the model adaptively according to the input image sequences. The running average approach for the update of the background model B_t is described as follows:

$$B_t = (1 - \alpha)\, B_{t-1} + \alpha\, I_t \quad (1)$$

Where, α is the pre-determined "learning rate" It is the current pixel intensity value and B_{t-1} is the previous running average of the background model. The other parameter of the Gaussian model, the standard deviation σ, can be updated similarly using the same learning rate α:

$$\sigma_t = (1 - \alpha)\sigma_{t-1} + \alpha(I_t - B_t) \quad (2)$$

Foreground object detection and segmentation from a video sequences is one of the essential task in video surveillance. Foreground pixel are detected by calculating the Euclidean norm,

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$$H(u,v)=\begin{cases}1, & \text{if}|(u,v)-F(u,v)|S \\ 0, & otherwise\end{cases} \quad (3)$$

A foreground-background pixel classification method using adaptive thresholding is presented. Thresholding is used to classify a pixel is a foreground or background pixel, and the results are represented using a binary foreground mask FG(x,y),

$$FG(x,y)=\begin{cases}1 & if\ |I_t - B_t| > k\sigma_t \\ 0 & otherwise\end{cases} \quad (4)$$

Where, k is a constant, It is the pixel intensity of the urrent frame.

B) Blob Analysis

Blob detection demotes mathematical methods that are recognized at detecting regions in a digital image that differ in properties, such as brightness or color, calculated to areas neighbouring to those regions. A blob is an area of a digital image in which some belongings are stable or vary within a decided range of values; all the points in a blob can be consider in some sense to be similar to each other. A blob is an area of poignant pixels with the same logical state. All pixels in an image that is in the right place to a blob are in a foreground state. All pixels are in background state. Blob Analysis is a basic method of appliance vision based on testing of trustworthy image region. As such it is a tool of option for relevance in which the objects being examined are obviously visible from the background. Different set of Blob Analysis method allow to make modified solution for a broad range of ocular scrutiny problems. Main advantages of this method include high litheness and outstanding performance. Its extractions are clear background-foreground relative condition.

C) Abnormal Crowd Detection and Tracking

Crowd monitoring and activities understanding using visual methods is significant in many surveillance applications. Crowd density evaluation is one of the most fascinating nuisances in crowd analysis. A common application on crowd density evaluation is automatic monitoring of the crowd density in communal places for security control such as crowd congestion detection and evacuation detection. Most methods proposed in the literature can be categorized into two types: direct and indirect approaches. Direct approach is a detection based method that detects each individual person in a scene using segmentation or human detection. The total number of persons can then be determined easily. Some of these methods involve explicit detection, tracking, and monitoring of individuals in the scene such as the use of histogram of oriented gradients (HOG) features for person and the indirect approach is a map based approach that maps some detected visual features to the number of people. Crowd movement tracking is quite altered from tracking individuals in the crowd.

Visual object tracking is an important step in many applications such as human-computer interaction, medical imaging, video analytics, augmented reality, and gesture recognition. Object tracking is used for much application such as motion-based detection, automatic surveillance, video indexing and rescue, human computer communication and traffic monitor etc. Object tracking can be classified into several steps, such as object illustration, characteristic selection for tracking, object detection, background subtraction, and object segmentation. The object tracking complexity can be modelled by the state-space demonstration:

1. State Equation:

$$X_t = f_t(x_{t-1}, v_t) \quad (5)$$

2. Measurement Equation:

$$Z_t = h_t(x_t, n_t) \quad (6)$$

Where, ft is the function which defines the state evolves at time t, and ht is the function denotes the measurement of the at time t. Object tracking is one of the most significant mechanisms in a broad range of application in computer visualization, such as surveillance, human computer communication, and medical imaging. Given the initialized state (e.g., position and size) of a goal object in a frame of a video, the goal of tracking is to evaluate the states of the goal in the succeeding frames. Even though object tracking has been deliberate for a number of decades, and much development has been completed in recent years. Frequent factor affect the presentation of a tracking algorithm, such as explanation difference, occlusion, as well as background clutter, and there exists no single tracking advance that can effectively feel all scenario. Therefore, it is critical to estimate the presentation of state-of-the-art trackers to display their strength and Weakness and help recognize future research instructions in this field for manipulative more robust algorithms.

When persons are being tracked, the in order is compute at the level of every person. But when we chat about crowd tracking, the centre of attention is on the movement of a crowd as a set of tiny element whose arrangement change continuously, instead of tracking the same entity throughout the video. A relevance of crowd tracking is the use of crowd tracking to create models of crowd activities and to detect abnormal behaviours at the crowd level rather than at the individual level. Crowd analysis also finds application in crowd simulation, crowd managing, failure management, outlet planning as well as other related areas. There are dissimilar research topics in video surveillance related to crowds: crowd density evaluation, face detection and detection in crowds, crowd behaviour monitor. In this paper, we focus on the problem of crowd activities and abnormal event detection in crowd flows. Our approach does not look for a general model usable for all the scenes and the entire scenario. Instead, for each end-user situation, devoted models of crowd events are defined. This leads to many simple but robust models. It requires in turn correct tools for fast modeling.

IV. EXPERIMENTAL RESULTS

The experimental results are shown in Fig.2, 3 and 4. As our primary aim to detect and track abnormal crowd activities in the video sequences, we use input video taken

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from public datasets UMN. Abnormal person and crowd are first detected in the input video. Then background subtraction processes are carried out. After that, abnormal crowd is tracked efficiently with our proposed method. Corresponding results are shown in the Figures 2, 3 and 4.

Each pixel in a background subtraction method's classification was determined to be: true positive (TN) for a correctly classified foreground pixel, false positive (FP) for a background pixel that was incorrectly classified as foreground, true negative (TN) for a correctly classified background pixel, and false negative (FN) for a foreground pixel that was incorrectly classified as background. By the calculation of TP, TN, FP, and FN the different methods can be evaluated. Then the sensitivity, the specificity and accuracy was calculated by using the formula given in equation7, 8and9. Sensitivity is defined in equation 7; specificity is defined in equation 8 and accuracy is defined in equation 9. Table 1 shows the quantitative results of various frames of proposed method. Our experimental results show that the proposed method is more efficient and robust for abnormal crowd detection and tracking.

$$Sensitivity = \frac{TP}{TP+FN} \qquad (7)$$

$$Specificity = \frac{TN}{FP+TN} \qquad (8)$$

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \qquad (9)$$

Fig.2.a) Input Frame A

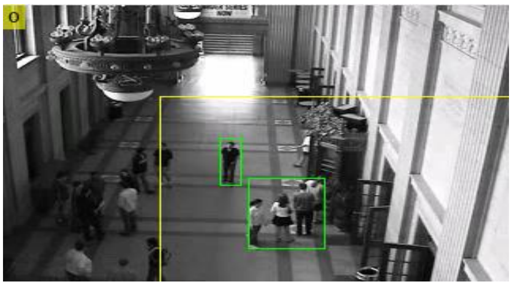

Fig.2.b) Abnormal Crowd Detection

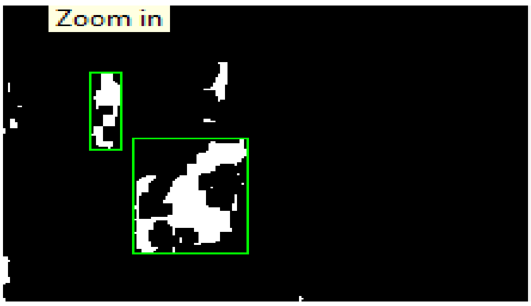

Fig.2.c) Background Subtracted Frame A

Fig.3.a) Abnormal Crowd Detection

Fig.3.b) Abnormal Crowd Tracked Frame B

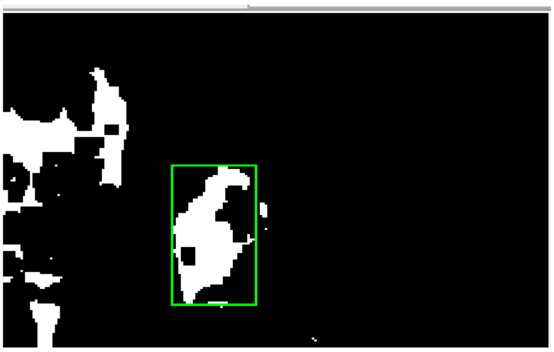

Fig.3.c) Background Subtracted Frame B

Fig.4.a) Abnormal Crowd Activity

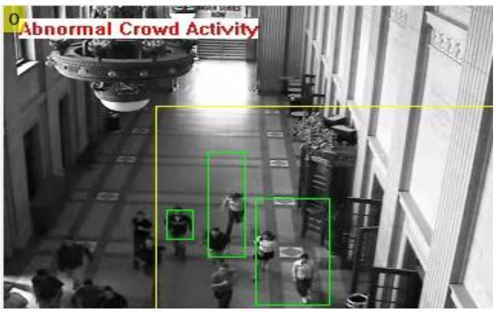

Fig.4.b) Abnormal Crowd Tracked Frame C

Fig.4.c) Background Subtracted Frame C

TABLE I: BACKGROUND SUBTRACTION RESULTS OF VARIOUS FRAMES OF PROPOSED METHOD

S.No	Frames	Sensitivity	Specificity	Accuracy
1	Frame A	0.9321	0.9657	0.9735
2	Frame B	0.9259	0.9734	0.9678
3	Frame C	0.9467	0.9614	0.9710

V. CONCLUSION

This paper has shown that it is feasible to use well-established image processing techniques for monitoring and collecting data on crowd activities. All object hypotheses that are essential to clarify the foreground of a video structure are jointly inferred. The approach is similar in its strength to background subtraction methods used in video surveillance systems. The proposed model incorporates the intensively explored semantic scene knowledge and social communications among persons, and the experimental results have demonstrated its feasibility and robustness.

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Dr. C. Sureshkumar received M.E degree in Computer Science in 2006, and Ph.D. in Computer Science and Engineering in 2011, both from Anna University, Tamil Nadu, India. He is working as Principal in J.K.K.Nattraja College of Engineering and Technology, Namakkal, Tamil Nadu. He has published many papers in computer vision applied to automation, motion analysis, image matching, image classification and view based object recognition and management oriented empirical and conceptual papers in leading journals and magazines. His present research is focused on statistical learning and its application to computer vision and image understanding, problem recognition and video surveillance.