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Prediction of Crowd in Three Levels: a Foot Step to Anomalies Prevention

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Abstract*: Crowd is a huge number of people meet jointly in a disorganized or unmanageable way. Crowd in any atmosphere may leads to suspicious events. Nobody can predict the crowd and some anomalies might happen in the presence of crowd. So prevention of crowd well in advance is the only remedy to tackle the situation. Advance crowd detection is an important subfield in video surveillance. Prior detection or prevention of crowd has so much of importance while we are considering the present scenarios all over the world. So now-days, an automatic crowd prevention technique is needed for all the countries to protect their land, provide safety for their citizens and law enforcement. Crowd prevention system using manual operators are weak due to many physiological and non-physiological factors but it will provide better performance than automatic system in case of decision making. Many models have been developed so far to detect the crowd automatically. Our system aims to predict the crowd well in advance in three levels and so the automatic system or the operator will get enough time to respond or take a decision. To detect the formation of crowd well in advance, all the human objects in a frame was identified by Gaussian mixture model and object classification, shadow was eliminated and crowd was predicted using the object rectangle model and center vertical line model. The pixel distance between the each rectangles and center line is used to predict the formation of crowd. This paper also gives some suggestions to crowd modelling.

Keywords: Video Surveillance System, Anomalies Detection Crowd Detection, Advance Crowd detection

I. INTRODUCTION

A. Computer Vision and Video Surveillance

In modern world, the uses of surveillance cameras that have been installed to monitor private and public spaces are increased dramatically. Computer vision can be taken as a study of an image or a scene with the use of optical detection method for the purpose of gathering information and to control the processes. The control or decision making in computer vision was being done by either human operators or automatically. Automatic computer vision is an artificial application of a variety of sciences and technologies connected to digital computer. Computer vision has much number of applications in the field of video surveillance. The video surveillance systems are the widespread apparatus for observing, supervision and law enforcement in public areas.

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The primary aims of video surveillance systems are to provide an automatic interpretation of scenes and to recognize and estimate the movements and interactions of the observed objects based on the information acquired by sensors or video surveillance systems have the ability to monitor and it should be able to track specific objects in the complex environment for any abnormal behaviours. Video surveillance systems are useful for access control, person identification, anomalies detection etc [1].

B. Anomalies Detection in Surveillance Sites

Today, the importance of ensuring security in public sites is growing because of the r0ecently happened terrorists and crime action in all over the world. Capturing and observing the videos in any surveillance sites are able to detect a variety of genuine anomalies. Here the main problem comes up with the fast development and increase of urbanization includes traffic congestion, accidents, and traffic violations etc. Mostly, anomalous actions seldom happen as compared to normal activities [2]. So apart from monitoring all video segments or clips, which is very time consuming, detecting anomalous segments or clips well in advance are gaining popularity. Modelling action patterns and human behaviours for finding or recognizing a strange event is a thoughtful technology which has concerned amazing research attention in the last few years. Consequently, to lessen the waste of labour and time, developing intelligent computer vision algorithms for automatic video anomaly detection is a pressing need. The aim of a real-world anomaly detection system is to timely indicate an activity that deviates from normal patterns and identify the time window of the happening anomaly [2]. Real-life anomalous occasions are complex and dissimilar and therefore it is difficult to list out all of the probable anomalous events. Consequently, it is desirable that the anomaly detection algorithm does not rely on any previous information about the occasions.

C. Crowd Detection and Estimation

In modern years, numerals of security agencies are listening carefully in crowd management to because any anomalies are possible to happen in crowd [3]. Crowd learning is one of the major applications of video surveillance system. Crowd study was find applications in crowd simulation, crowd managing, disaster management, road planning as well as other related areas like crowd counting and thickness finding etc. Crowd detection is principally essential in thick urban areas where pedestrians are moving in groups and this can be done by radar signals but the cost of the system will be very high.
So currently, this was done with image processing techniques with low cost [4].

When we examine the crowd detection system worldwide in a decade, we have noted that most of the systems address only the people counting. The ultimate requirements of these systems lead to detect groups, count people, detect if an attendance level is reached. Although in some way, counting of people is very helpful for detecting the congestion in a traffic site or streets or for checking the business done in a shop. But in real practice, crowd observation cannot be compact to simple people counting. Detecting humans in images is a tough task due to their variable look and the extensive range of poses that they take on.

D. Finding on Existing Crowd Detection Models

Over the years, a number of intelligent crowd surveillance systems have been developed for effective and efficient processing of the video footage generated by the surveillance cameras. All the existing crowd detection models can detect the crowd or estimate the crowd in different scenarios, but they failed to detect the crowd well in advance. Since the crowd formation is unexpected, prior detection of crowd is very important in video surveillance sites. But, despite the complexity of these systems, they have not yet achieved the desirable level of applicability and strength required for the real-world settings and uncontrolled conditions. If the prior detection of crowd is performed, that will help the authorities to prevent the formation of suspicious crowd in surveillance sites.

This section also gives some findings about the crowd models that were noted in the research phase and we have developed a framework for prior detection of crowd. To learn or duplicate the dynamics of a crowd, researchers have to consider a number of physical factors, social factors, and psychological factors while describing the crowds in their models. Several works aspires at the “outside characteristics” of a crowd, such as look, poses or movement patterns, corresponding location of individuals; and some other job focuses on how a crowd’s public behaviors progress over time upon some events. The crowd size frequently determines the categories of approaches used to model a crowd. Crowd modelling should be done either as long term or short term phenomena when the time scale of crowd is concerned.

E. General Framework for Crowd Modeling

As a cooperative and extremely active social group, human crowd is a charming occurrence which has been continuously worried by experts from various areas. Crowd detection in public places is growing at an exceptional rate, from closed-circuit security systems to modern systems that can monitor individuals at airports, subways, concerts, sporting events etc., to network of cameras covering important locations within a city. Presently, computer-based modelling and simulation technology have come forward to support the study of the dynamics of crowds, such as a crowd’s behaviors under ordinary and growing situations.

Figure 1 shows a general architecture of all crowd detection models that were used today. Video capturing was done using a camera and the crowded video footage is used to detect all the human objects in the consecutive frames. Any digital camera can be used for this purpose because resolution of video frame is not a big issue. This is the first step that was performed in most of the crowd detection model and a sample result is shown in figure 2. To detect the crowd event, some preprocessing works has to be carried out for all the video image frames [5].

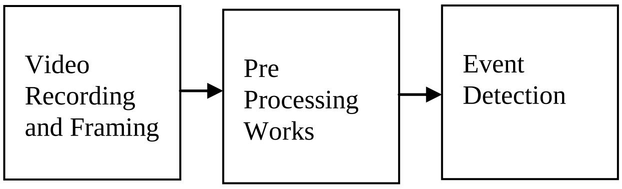

Fig. 1. A Frame work for General Crowd Detection Model

Fig. 2.Input Video Frames

The primary aim for applying preprocessing works to video image frames is to prepare all frames for event detection. Various crowd detection models were developed for the event detection phase to detect either the crowd or crowd count using variety of concepts. For detecting the crowd event, the object contoures in all the frames must be determined. This research method section gives some new suggestions for detecting the crowd and was noted as strong working models in the development phase of our proposed advance crowd detection model.

II. REVIEW LITERATURE

A. Object Detection

This literature gives an over view of the moving object detection algorithms that was studied and we found that background subtraction methods are the best commonly used object detection algorithms because of its simplicity and robustness. So we have implemented and the results were compared in this work. Here, we have conducted a study to find the efficiency of various background subtraction techniques such as frame differencing, adaptive median filtering etc. The Gaussian Mixture model introduced by Stauffer and Grimson’s shows suitable results as compared to other models. Gaussian mixture modeling for background estimation is a pixel based procedure. Now it is the most widely used method for background subtraction due to its speed, simplicity and the easiness of execution.

So in the proposed system, GMM is selected as the basic step that was performed before further processing of the image frames [6].

B. Shadow Elimination

Shadows may cause confusion for video applications. Objects with shadows forms a distorted figures and neighboring objects may be joined through shadows. Both can confuse object recognition systems. So segmenting objects from shadows is a nontrivial job. Shadows was broadly divided into cast and self-shadows. Self-shadow is the part of an object, which is not illuminated properly by the light source. The cast shadow lying beside the objects that belongs to the background. For object recognition and many other applications, cast shadows are undesired and must be eliminated, while self-shadows are the parts of an object and should be preserved. The objects have intensities similar to those of shadows; shadow removal could become extremely difficult [7].

Many techniques have been proposed for removing shadows from images. In the method proposed by Scanlan, et al. [5], the input image is first divided into blocks. For each block, the mean intensity value of the block is computed. Next, from the mean values of all blocks the median of the mean values is determined. Thereafter, for each block a local ratio is calculated by dividing the median with the local mean value of the block. The pixel values of the block are then multiplied by the ratio. If there are shadows existing in the block, they will be suppressed after the multiplication. In Fathy and Siyal's work [8], shadow models were constructed beforehand from motion figures extracted from video sequences. Constructed shadow models were later used **as** references for recovering objects from the figures detected in the input video sequences. The major weakness of this method is that objects with colors close to black are easily regarded as shadows.

III. RESEARCH METHOD

A. Earlier Crowd Detection in Three Levels

A frequent analysis on human crowd is that, a person may perform somewhat differently in a crowd as compared to performing individually. Consequently, a crowd may show extremely composite dynamics. In general, pure statistical approaches or logical models are not sufficient in distinguish the dynamics of a crowd. All the crowd models that are available on today can detect the crowd when it is formed but failed to detect the crowd before it is happening. So the decision making by either the system or the authorized personal is not effective because of the lack of time to respond to a situations.

Prior detection of crowd was performed using object bounding rectangular model and central vertical line model. To create object bounding rectangles to each object in a frame, we have extracted some features like area, centroid, four corner points of each object and the diameter etc of an image [9]. By utilizing the coordinates of these corner points, a rectangle was drawn and from these rectangles, centre point was calculated. Now centre points for the entire object surrounding rectangle in a frame is calculated. By moving through this centre point, a vertical line is created for all the objects present in the video frames. The distance between the rectangular boxes and perpendicular axis was utilized to detect the crowd in a prior fashion. Rectangular box only can detect the loose crowd but it cannot be used for the detection of thick crowd and crowd prediction. When two object comes very closer, the object bounding rectangles will be merged as single. But each object contains different central perpendicular axis. So distance between these axes in multiple objects can be taken as a sign of formation of crowd. If this distance falls below a pre- defined threshold, chance of crowd can be predicted. In this work, we have detected the anomalies by predicting the crowd at three levels. Lowest risk level, Medium risk level and High risk level. A frame work is given in figure 3.

In the proposed work, crowd video capturing is done using a stationary camera and the crowded video footage is stored. Object detection is carried out by using GMM (Gaussian Mixture model).The GMM is the expansion of Gaussian probability density function. Gaussian mixture model is widely used approach for background modeling to detect moving objects from fixed stationary camera. This model is more robust than other models and in this method, all objects can be filtered out and each pixel location is represented as a mixture of Gaussian functions to form a probability distribution function [6]. In this method, Gaussians are calculated and decide which Gaussians matches up to the background based on the resolution and the variance of all Gaussians. Thus, based on the Gaussian threshold, the object pixel and background pixels are categorized as white and black pixels. Thus the resultant background of each frame contains only black pixels and the object contour will contains only white pixels. The Gaussian mixture model can categorize white and black pixels with negligible noise pixels than that of commonly used background subtraction methods [6].

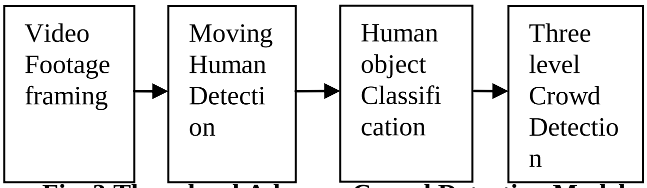

Fig. 3.Three level Advance Crowd Detection Model

The next step is to use some steps to eliminate noise and shadow. The noises are normally appeared as white pixels in background image and black pixels in foreground image. Camera noise and irregular object movement noises should be clean out from the image frame with the use of morphological operations. The morphological operations are to search the image with a simple pre-defined shape, illustrating conclusions on how this shape fits or misses the shapes in the image. Morphological operations consists of some structure elements like disk, square and cross shaped elements fixed sizes. The essential operations of binary morphology operations are dilation, erosion, closing, and opening. Dilation operation enlarges the region, while erosion makes the region small. Closing operation is defined as performing erosion after dilation and it can fill the internal holes in the region [10].

The object shadow creates erroneous result in the object detection process. Due to the shadow human object shape cannot be predicted. So it is very essential to use a shadow detection algorithm to eliminate shadow pixels in each frame. We can conclude that the choice of the best shadow detection /removal method depends on the characteristics of data set being used. Color based method is applicable for any coloured image but may fail when intensity of shadow and background is same and color of objects is same or darker than background. Moving object classification is a difficult process in the presence of shadows. In the proposed system, we have removed the shadow using a threshold. Battacharya distance was calculated using battacharya equation and this distance was taken as the threshold to categorize the shadow pixels and foreground pixels. This method was performed well in eliminating the extract shadow region.

The object classification is highly needful to separate the moving human objects from the other moving objects. It is the most accuracy deciding factor of crowd detection algorithm. Classification is the process of assigning a group for many similar objects [11]. The moving region extracted after background subtraction may have different targets like pedestrians, vehicles, clutter and other moving objects such as birds etc. From these targets we should detect the human objects for further analysis. When deciding on a classification method, we must think about the situation and how many objects are present in the environment. We can choose simple classification algorithm, if only one object is present. If more than one object is present in an environment, then a distinguishing characteristic of objects needs to be identified. Similarly when the objects are very similar, more than one characteristic should be considered. But the processing time will be high when more than one characteristic is used. In the proposed system, shape based classification method presented by Yiğithan Dedeoğlu is applied to classify objects as human and human group.

IV. RESULT AND DISCUSSIONS

In this section, the results of research are explained and at the same time is given the comprehensive discussion. Results can be presented in figures that make the reader understand easily.

A. Object Bounding Rectangles

By applying our algorithm to all the image frames, rectangular boxes will be created around all the foreground objects contains in that frame. Fig. 4 shows the result of object bounding rectangle model.

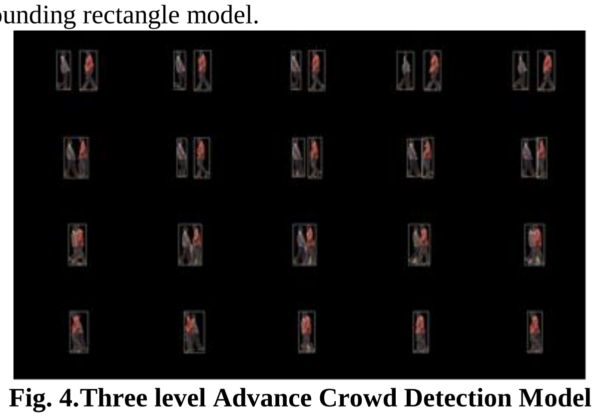

Fig. 4.Three level Advance Crowd Detection Model

B. Object Centre Model

We have found that finding centre points of each object bounding rectangle and by measuring the distance between these centre points are very useful to detect crowd. Thus formation of crowd well in advance was carried out by checking the deviation of the distance between the objects from a threshold value. But the centre point model was lossy in the dense crowd and it doesn't give any directional vector. Figure 5 shows the result of object centre calculation for one frame.

Fig. 5.Object Centre Model

C. Central Perpendicular Line Model

Direction of crowd is an important parameter in all crowd video surveillance sites. To overcome the shortcomings of centre point model, we have created a central perpendicular line model and found that it can detect the crowd direction and predict the crowd.

This model was found as a remedy for detecting the crowd well in advance. Fig. 6 shows the result of perpendicular line creation through all object centres.

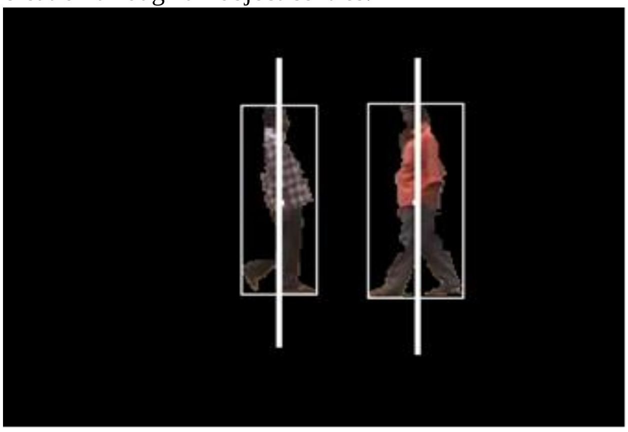

Fig. 6.Centre Vertical Line Model

D. Advance Crowd Detection Model

Prediction of crowd well in advance by using our object bounding rectangle and central vertical line model. The rectangle model will not perform better in the thick crowded video frames. So the central vertical line model will help us to detect the crowd in a prior fashion on three levels. Figure 7 shows the result of crowd detection in three different distances.

The highly risk level of crowd formation is represented by the system as green marking, medium risk level is represented as yellow and low risk level is represented by red colour.

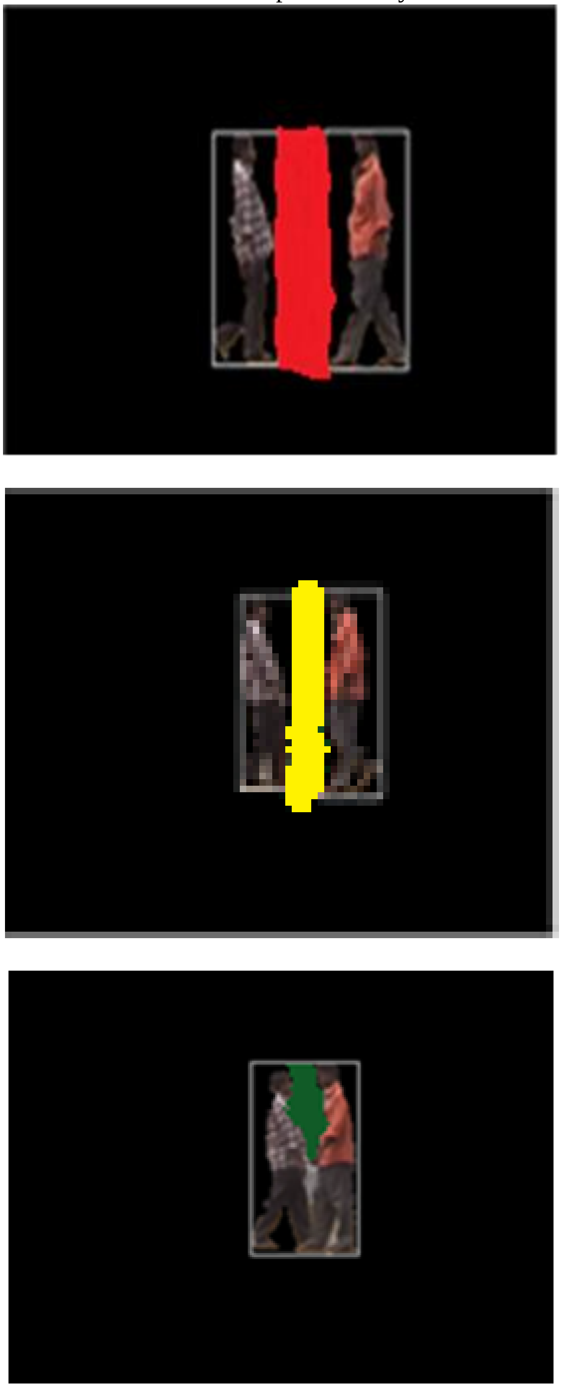

Fig. 7.Crowd Prediction in Three Levels

E. Equations

Researchers are commonly used the PSNR to measure the quality of reconstructed or modified images. All picture element (pixel) has a color value that can be varied when an image is reconstructed or modified. The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) are the two error measures used to equate image excellence. The MSE represents the collective squared error between the compressed and the original image. But the PSNR represents a measure of the peak error. If the value of MSE is lower, the lower the error.

The PSNR computes the peak signal-to-noise ratio, in decibels, between two images. This ratio is often used as a quality depth between the original and a compressed image [10]. To compute the PSNR, the mean-squared error must be calculated using the following equation (1)

$$MSE = \sum_{M,N} [I_1(m,n) - I_2(m,n)]^2 / (M * N) \qquad (1)$$

In the equation 1, M and N are the number of rows and columns in the input images. Then the PSNR can be calculated using the following equation (2)

PSNR+10log10 {[R2]/MSE} (2)

In the above equation, R is the maximum variation in the input image data type. If the input image is a double-precision floating-point data, then R is 1. If it is a 8-bit unsigned integer data type, R is 255, etc. [12]

F. Tables

Analyzing our models by comparing it with the existing models is a time consuming and useless process. So this section give a focus to analyze and evaluate the principal model which is developed for object detection. is highly needful to separate the moving human objects from the background. It is the most accuracy deducting factor in crowd detection algorithm. If the object detection has been done accurately in all the video image frames, all other steps will performed as better. From this point we have concentrated deeply to in the selection of a suitable object detection algorithm. After the proper analysis, it is found that GMM gives high PSNR value than other methods in different video data sets. Higher PSNR usually indicates that the reconstruction is of higher quality. Comparison of commonly used background subtraction methods for different videos is given in the table 1.

Table- I: The performance of human detection in video images

Performance Evaluation using PSNR					
Video Clip	**Video 1**	**Video 2**	**Video 3**	**Video 4**	**Video 5**
Adaptive Background	**28.75**	**25.62**	**32.1**	**35.33**	**22.5**
Frame Differencing	**40.17**	**38.14**	**42.34**	**45.55**	**28.34**
Average Filter	**42.35**	**40.35**	**45.25**	**46.28**	**30.1**
GMM	**52.58**	**45.52**	**48.5**	**50.12**	**35.12**

V. CONCLUSION

Our main contribution in this paper is to implement our innovative idea for predicting the crowd in video images. This paper was mainly focused on crowd detection and the proposed model can detect the crowd well in advance in three levels by image processing principles. We have studied different algorithms on crowd detection and from these studies we have used some methods for new crowd models and also found that our prior detection of crowd is very useful to detect and prevent all the human anomalies happened in crowd by taking crowd as a smoke screen.

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