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# Unusual Event Detection in Low Resolution Video

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***Abstract*— In real world applications, securing video is more important due to the happening of unusual events. Moving object detection and tracking is difficult in low resolution video and it became a challenging task due to loss of discriminative detail in visual appearance. The existing methods use super resolution techniques to enhance the low resolution video. But these methods are not economical. The cost further increases for event detection. This paper presents an algorithm to detect unusual events without using any super resolution techniques and it is useful for security purpose where low resolution cameras are used due to low cost. This algorithm uses background subtraction technique to detect object of interest from the background. This approach uses close morphological operation with structuring element in pre-processing step. Proposed algorithm is able to detect unusual events such as overcrowding or fight in low resolution video by using standard deviation. It process low resolution frames, so this is fast and helpful in video surveillance system where low resolution cameras are used. Since the use of classifiers is avoided in our algorithm, there is no need of training requirement.**

***Keywords*- Background subtraction, low resolution video, morphological operation, Object detection, unusual event detection, video surveillance.**

## I. INTRODUCTION

Many significant efforts have been put in the field of moving object detection to make few applications reliable, robust and efficient: video surveillance, authentication system, robotics etc. There are many challenges which produce difficulties in the improvement of these applications. The challenges include illumination change, dynamic background, occlusion, shadow etc. as in [1]. These obstacles become more burden by performing detection and tracking in low resolution video. In low resolution video it is very difficult to exactly finding out the object of interest because most of the details such as visual features and primitives have been lost. It results in inefficient event detection.But there are some benefits of using low resolution video, low processing and transmission time, low storage.

Some approaches will use low resolution input in initial stages and later these videos will be enhanced to high resolution using super resolution techniques. Most of the algorithms are based on the high resolution (HR) video for obtaining the contour and shape features of target. These methods use high resolution frames and cost will be more.

There are classifiers which require learning time and careful attention to train the dataset. Where in the unusual event detection, most of the methods uses classifiers to detect the events and does not use low resolution input. Some approaches require manual setup initially in the automated event detection system and have high computational cost. There is need of an algorithm which is capable to detect uncommon events in low resolution video without human intervention.

This paper presents an algorithm which is able to detect abnormal events in low resolution video. This approach will enhance the security by using low resolution camera. It uses background subtraction technique to segment the foreground object with dynamic background and preserves object features simply by the application of morphological operation with structuring element. In real time applications, classifiers are not used instead of that statistical property standard deviation is utilized.

## II. VIDEO SURVEILLANCE SYSTEM

Object tracking system includes four main building blocks for the video surveillance system as in [2]:

- Moving object detection
- Object tracking
- Event recognition
- Object identification

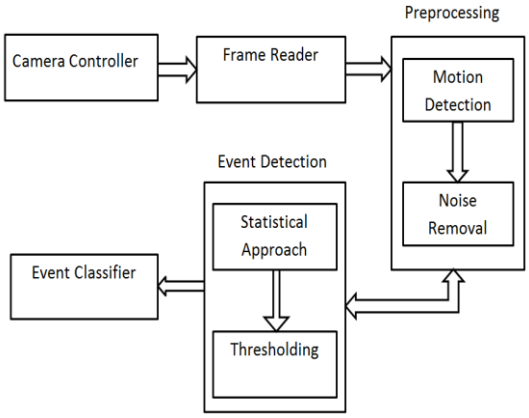


***Figure 1: Block diagram of the system***

### *A. Moving object detection:*

Video surveillance is one of the most important applications among them which will identify the changes in scene. Due to the use of identifying changes in image sequence there are vast numbers of applications developed in several areas. There are different methods that are used to detect changes. These approaches are classified as follows:

- Frame differencing.
- Background modelling and subtraction.

#### *1. Frame differencing*

In this method difference of pixels is calculated for two or more consecutive frames in a video to detect the moving regions. Difference is calculated by setting the adaptive threshold to get region of changes. This method does not work when the object has uniform texture or move slowly as in [3]. If the object stops moving this method fails. Let $P_n(t)$ be the gray level intensity value at the 't' pixel position. Let 'D' be the threshold value.

$$|P_n(t) - P_{n-1}(t)| > D \quad (1)$$

If the frame difference value is greater than the threshold value then it is a foreground pixel. Similarly if it is less than the threshold it is a background pixel. This method is adaptive to static environment only. It requires less computational cost but performance is poor.

#### *2. Background modeling and subtraction*

Background subtraction is mainly used for identifying moving objects in videos from surveillance cameras. In the fields of image processing background subtraction is a technique where an image foreground is drawn out for object identification. In general,objects like humans, cars, text etc. are the image's region of interest in its background. The difference between the current frame and a reference frame, often called "background image", is the basis for the approach of detecting the moving objects as in [4].

### *B. Object Tracking*

Obtaining the correct tracking information of moving foreground object is not easy task in events like modeling and activity recognition. For this purpose many different type of algorithm have been used. Most of these algorithms are divided into four different groups: Model based, Region based, Contour based, Feature based.

### *C. Event Recognition*

The major purpose of event recognition is to develop a fully automated surveillance system. Many studies propose different kinds of events as in [5].In this step objects are detected by using background subtraction and then their boundaries are extracted to produce a skeleton. This skeleton provides important motion cues, such as body posture etc. Motion activities of segmented skeletons/blobs can be utilized in event detection and recognition, such as walking or running, fight or theft, overcrowding etc.

### *D. Object Identification*

Another important part of a surveillance system is detecting the moving object entering the scene. Biometrics such as Face and gait are now used in person identification, based on the latest studies.

## III. PROPOSED APPROACH

The proposed procedure is utilized just to detect unusual event, for example, fight and overcrowding for the low resolution video especially utilized in the ATM. This algorithm is divided into the accompanying sections:

- Background Subtraction Technique
- Close Morphological Operation (o)
- Standard Deviation (σ)
- Pseudo Code of Proposed Approach

### *A. Background Subtraction Technique*

The identification of a foreground objects in an image taken from a stationary camerais done by using background subtraction. These are the steps that are to be followed for the background subtraction technique.

***1) Video Acquisition:*** This step deals with acquiring the video by any one of the video capturing device such as Webcam, Mobile camera, USB camera, CCTV camera etc.

***2) Frame conversion****:* After capturing the video, it is converted into frames of suitable type so that further processing could be done conveniently.

***3) Pre-processing:*** Some pre-processing is applied on the frames of the video to reduce noise. There are some

common methods of pre-processing as in [6]: Smooth, Dilate, Erode, Median, Open, Close etc.

***4) Background Modeling:*** According to the literature there are several background modelling techniques which are categorized as recursive or non-recursive techniques as in [7]. After pre-processing background modeling is used to create an ideal background (static or dynamic) according to environmental changes. This is an important step of the system that sometime may include image subtraction operations.

***5) Background Subtraction****:* This is the main step. Here any significant changes in the image region from background model are identified & further processing will be done on the pixels constituting the changes. Usually connected component labelling algorithm is applied to obtain connected regions corresponding to the object.

***6) Post processing:*** This is done to improve the results. There are many post processing techniques. These techniques have an objective to improve foreground mask.

***7) Foreground extraction****:* This is the final step in the process which extracts the moving object from the frame. The result of this step helps in the judgment of the efficiency of the background subtraction system.

### *B. Close Morphological Operation*

Close Morphological Operation useful in decreasing noise which stays in the moving object. Closing operation is made out of two sub-operations: dilation then followed by erosion as in [8]. In dilation, those pixels which are touching the object pixels are changed to object pixels. Dilation adds pixels to the boundary of the object and closes segregated background pixel. While in erosion, every object pixel that is touching a background pixel is changed into a background pixel. Erosion expels detached foreground pixels.

The property of morphological operation to remove noise makes it appropriate to our objective since creating masks which preserve the object boundary is much more important. This preserved boundary is useful in effective usage of connected component algorithm, which is used further in the estimation of the blob's area. Composite type of dilation took after by erosion (Closing) morphological operation can be expressed as:

$$\mathbf{F_t = F_t \, o \, D_\rho} \qquad (2)$$

Here 'o' is the morphological closing operation and 'Dρ' is disk like structuring element of radius 'ρ'. There are many structuring elements whose shape and size choice depends on the type of information one wants to retrieve as in [9].

### *C. Standard Deviation*

Standard deviation (σ) is a measure that is used to evaluate the dispersion from the average value as in [10]. A low standard deviation indicates that the information points have a tendency to be close to the mean and high standard deviation indicates that the data points are spread out over a vast scope of values. The standard deviation is:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2} \qquad (3)$$

Here N is the number of samples in population, μ is the mean value, xi is the sample value and σ is the standard deviation. In the proposed scheme the calculation of standard deviation of the population of centroids of the blobs in '*n*' consecutive frames. If this standard deviation is above than a threshold value continuously '*x*' time then it signifies the presence of unusual event.

### *D. Pseudo Code of Proposed Approach*

Here in this process the first step is to segment the moving object from the frame using background subtraction procedure. At that point the refinement of the result is done by closing morphological operation followed by connected component labelling algorithm. Connected component algorithm joins the distinctive parts of same blobs either by using 4-connectivity or 8-connectivity. Area of these blobs are computed and then filtered through by the threshold value to avoid further processing of useless frames. In these useless frames little movement of blob occurs, such situations could be a person close to ATM machine, where just hands movements happen. Later standard deviation of blobs in these selected frames is calculated and verified them with another threshold value for the recognition of unusual event. This algorithm is sufficiently robust to manage the situation in which quick movement of single person occurs in the ATM such as picking of fallen ATM card from the floor and so on.

The algorithmic steps of the proposed scheme are given underneath: Here σ represents the standard deviation, T1 and T2 represents threshold values used for segmented area and standard deviation (σ) respectively. Segmented area, num_blobs, n, and x all represent numeric integer values as in [1].

1. Segment the moving objects from the current frame by using background subtraction technique.

2. Apply the close morphological operation with disk like structuring element on segmented areas to remove noise and other inaccuracies.

3. If ***segmented area*** (for each blob) >= ***T1*** then

4. ***num_blobs*** = ***num_blobs*** + 1

5. If***num_blobs*** > 1 then // overcrowding situation

6. Find out the centroids of the segmented blobs.

7. Calculate the ***standard deviation*** σ of centroid in '***n***' consecutive frames.

8. If '***x***' times (in continuity) ***standard deviation*** σ >= ***T2***, then

9. Unusual event occurred otherwise

10. Event is normal

End if of steps 8, 5 & 3 respectively.

In these experiments the value of "x" is equivalent to 3. This worth depends on the term of fight happened in the ATM. Through various experiments it is concluded that this value is sufficient to recognize fight even of small term. After the identification of unusual event the surveillance system can be robotized in such a way that it naturally locks the entryway of that specific ATM and sends the message to security personnel present in the normal observation room so that necessary move could be made.

## IV. EXPERIMENTS AND RESULTS

This process is demonstrated using MATLAB R 2015a on Intel core (TM) i3-3110M processor (2.4GHz), 4 GB RAM and Windows 8.The low resolution videos were taken with the help of Logitech webcam in '5mp' format.

Here MATLAB was used to plot graphs between the standard deviation and number of frames for different sample videos taken on the webcam. Each and every frame of the video is considered initially. Later processing will be done on the useful frames to detect unusual event. So to verify if an unusual event is done or not, it is determined by the references that were considered.

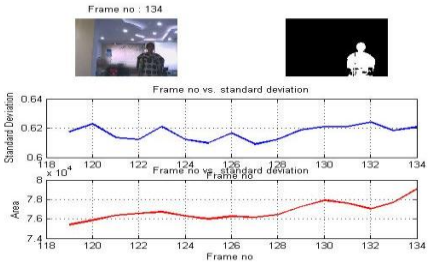


***Figure 2: variation of standard deviation and area***

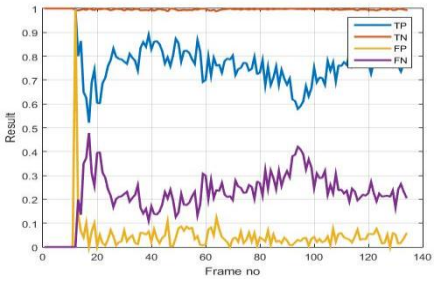


***Figure 3: TP, TN, FP, FN variation***

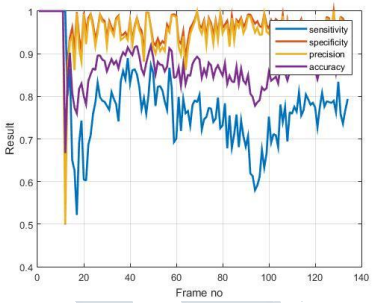


***Figure 4: sensitivity, specificity, precision variation***

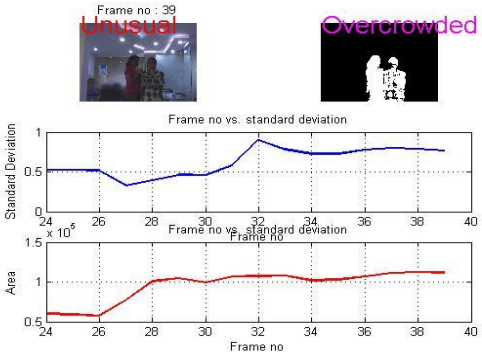


***Figure 5: variation of standard deviation and area***

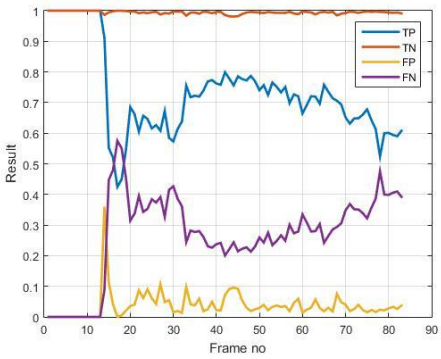


***Figure 6: TP, TN, FP, FN variation***

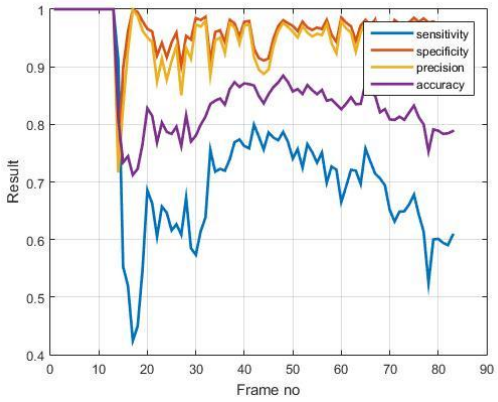


***Figure 7: sensitivity, specificity, precision variation***

***Sensitivity*** (also called the **true positive rate**) this is defined as when an unusual event occur the TP graph detects it and calculate the proportion of positives that are correctly identified as such (e.g., the percentage of unusual event detection correctly identified as having the condition).

***Specificity*** (also called the **true negative rate**) This is defined as when a normal event occurs this curve detects it as normal event and calculates the proportion of negatives that are correctly identified as such (e.g., the percentage of usual event detection correctly identified as not having unusual event).

These parameters were all taken from different sample videos as shown in figure 2 and figure 5. When compared, these parameters gives us the information about if any unusual event occurs like for example when two people enters the area and start to fight with each other. Thus following these results we can detect any unusual event for the low resolution video cameras.

## V. CONCLUSION

There is no need of using high computational scheme that improve low resolution videos by super resolution techniques. This proposed algorithm could be useful to upgrade the security of ATM where it is ready to recognize unusual event such as fight and overcrowding situation inside the ATM of various banks. The results show that above algorithm proficiently work on low resolution video, just by applying some pre-processing. Later on work this work can be stretched out to distinguish more unusual events in ATM such as to steal the ATM, Harming the ATM screen and robbery inside the ATM. This scheme could be further directed for that situation where one ATM room consists of two or more ATM machines. The proposed algorithm is the basic scheme for identifying unusual events but it can be modified to identify different problems by improving background subtraction techniques.

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