Motion Detection based on multi frame video under Surveillance System

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Abstract-

In this paper a series of algorithm has been formed to track the feature of motion detection under surveillance system. In the proposed work a pixel variant plays a vital role in detection of moving object of a particular clip. If there is a little bit motion in a frame then it is detected very easily by calculating pixel variance. This algorithm detects the zero variation only when there is no motion in a real-time video sequence. It is simple and easier for motion detection in the fames of moving object having Avi file. In this work we enhanced the efficiency of moving object detection in a current pair of frame by implementing pixel base displacement algorithm in the frame of object as the current and previous. There are different levels at which tracking can be performed. At the highest level, the whole body is detected without paying attention to the details of the posture and limbs. At a lower level, the posture and limbs are tracked. At an even lower level, one or two parts of the body (such as hands) are tracked. Most of the existing algorithms for moving object detection assume that the illumination in a scene remains constant. Unfortunately, this assumption is not valid, especially in outdoor environment. To resolve the problem of our existing methods (Simple Differencing method and Shading Model Method), we introduced an improvement "illumination compensation coefficient Ki" that makes it work well even when there is a moving object detected in the scene. In this work we present a new, illumination independent method for moving object detection in outdoor environment. We also used median value of the observed region instead of mean value in calculating the variance in proposed method because the comparison is faster than addition and division. It is shown in experimental results, this method is superior to other techniques if the illumination is allowed to vary. This paper answered the crucial question regarding the detection of moving object and suggests the requirement of surveillances in the terms of security and in high tech world. Our selection criteria are directly based on the definition of Motion detection and tracking algorithms which explains the experimental performance of motion detection in a frame generated by real-time video & clips. This is usually analyzing the difference of two successive frames with the help of pixel variance. Software .net is used for the accomplishment of task. The purpose of surveillance is to provide more information of moving object by tracking its motion in multi frames at any work places as banking, cinema hall, shopping mall, offices and structural work. From the experimental data we can explain the change in pixel variant means that changes had occurred from the current frame to previous frame.

1. Introduction

Motion detection under surveillances with tracking is an artificial intelligence that aims at giving vision to machines, which means to develop mathematical models, algorithms and technologies to build a machine with vision capabilities as advanced at least as human eyesight. A frequent task in the visual analysis of natural scenes is the tracking of moving objects. Trying to recognize a real-world object in a non-artificial surrounding will usually be a quite complex task and will probably need more computing time than is available from one single frame to the next. To overcome this problem one solution is to follow the target with the camera and hence to keep it in the center of the image. This approach is equivalent to determining the trajectory of a moving object in a large image. Such issues include the distinction and relative merits of pixel-based versus object based metrics; the motivation of appropriate metrics with impact of defining the end application; making explicit evaluation parameters and selecting appropriate values. This is usually analyzing the difference of two successive frames. With this we also described moving edges (Frames) by using a gradient-based optical flow technique and pixel base technique in the multi frames clip. Motion detection is the action of sensing the physical movement in a given area. It is also the process of determining the movement of an object from two or more successive images. Once the movement detection occurs, calculations are made from two images to determine the type of movement made. This can be achieved either by mechanical devices that physically interact with the field or by electronic devices that quantifies and measures changes in the given environment.

➢ Mechanical form of Motion Detection

A tripwire is a simple form of motion detection. If a moving object steps into the tripwire's field of view (i.e. trips the wire), then a simple sound device (e.g. bells) may alert the user. A glass filled to the brim so that surface

tension causes convex menus can be placed on top of an object to detect if the object has moved.

➢ Electronic form of Motion Detection

In the case of Electronic motion detection devices, such as motion detectors, have sensors that detect movement and send signals to a sound device that produces an alarm or switch on to image recording device. There are motion detectors which employ cameras connected to a computer which stores and manages captured images to be viewed later or viewed over a computer network.

Here we are proceeding with electronic form for image change detection based on multi frame video. The main idea is to identify the set of pixels that have undergone under some significant change between the current and previous images. These groups of pixels create what is often known as the change mask. Detecting and representing this change mask provides valuable information for the applications. This area is known as image understanding, which includes the object detection, object tracking, object classification, object Structure Analysis & identification and video encoding.

2. Method

Thresholding is the simplest method of image segmentation from a grayscale image. Here we are describing two existing methods and a proposed model method that realize moving object detection. One is simple differencing model method, second is shading modal method (existing) and third is proposed model method.

Simple Differencing Model Method work simply subtracting the current image and background image (that does not contain any moving object). The applied subtracting operation finds an absolute difference for each pixel, thus detecting moving objects (that have brighter or darker gray value), which usually differ from the background. If the difference is below a certain threshold, there is no change in the scene and the observed pixel is regarded as it belongs to the background. The shading model change detection algorithm uses the ratio of intensities recorded in a region of the two frames to detect this change. This method is superior to other techniques when the illumination is allowed to vary within ± 20% difference between background and current image. This method is not working for larger luminance changes. i.e. It is, roughly, illumination independent. The efficiency of these methods depends mostly on accuracy of background updating techniques and on the threshold choice.

Proposed modal method is illumination independent method for moving object detection in outdoor environment. This method is superior to other techniques if the illumination is allowed to vary. The proposed work is depicted in the block diagram of fig.2.1 as can be seen whole algorithm is comprised of 3 steps i.e. Tracking step, Detection step, Validation step for each video frame. In tracking step, a object is tracked to find their position and shape within the current video frame. In Detection step, a new hypotheses object is created with their estimated shape and motion in new current frame. In validation step, if any of the hypotheses are correct, then we have identified a new moving object at this frame and this will now be tracked through subsequent frames. In this methodology a pixel variant plays a vital role in detection of moving frame of a particular clip. If there is a little bit motion in a file then it is detected very easily by tracking pixel variance. Hence this method enhances the efficiency & occurs less error to track the motion.

The thresholding is classified into three types. They are

➢ Hard thresholding.
➢ Soft thresholding
➢ Qian thresholding

a) Hard thesholding: it can be defined as follow

$$D(Y,\lambda) = Y \text{ if } \| Y \| > \lambda$$

$$= 0 \text{ otherwise}$$

Where $Y = W(x)$ denote the forward wavelet transform operator, $D(Y,\lambda)$ denote the thresholding operator with threshold λ.

Hard threshold is a "keep or kill" procedure and is more intuitively appealing. The transfer function of the hard thresholding may seem to be natural. Sometimes pure noise coefficients may pass the hard threshold and appear as annoying 'blips' in the output.

b) Soft Thersolding or Wavelet shrinkage : It can be defined as follow

$$D(Y,\lambda) = \text{sign} (Y)(\| Y \| - \lambda) \text{ if } \| Y \| > \lambda$$

$$= 0 \text{ otherwise}$$

Soft threshold shrinks coefficients above the threshold in absolute value.

c) Qian thresholding : It incorporate the both hard and soft Thesholing and can be defined as follow

$$D(Y,\lambda)= Y (\| Y \|^Q - \lambda^Q)/ \| Y \|^Q \qquad \text{if } \| Y \| > \lambda$$
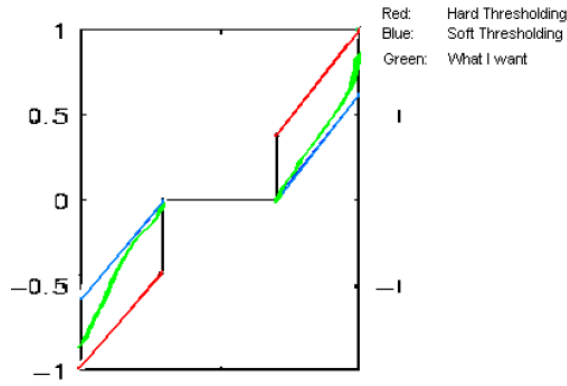
$$= 0 \text{ otherwise}$$

Fig. 1 Qian Thresholding

Soft thresholding is best in reducing noise but worst in preserving edges, and hard thresholding is best in preserving edges but worst in denoising. Qian thresholding achieves a compromise between the two extremes. It significantly reduces noise and well preserves edges at the same time. This can be clearly seen in above Figure, which shows the effectiveness between the three methods.

In our proposed method, three stage approaches is taken for each video frame:

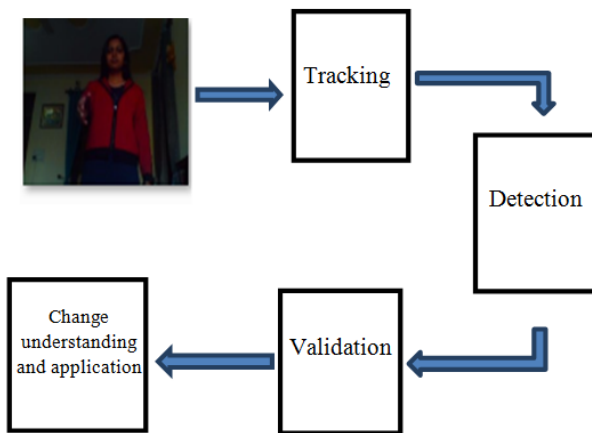- Tracking step
- Detection step
- Validation step

Fig. 2.1 segmentation frame work

Firstly, the objects, which have been previously identified, are tracked to find their position and shape within the current video frame. At the same time, the motion of these objects is estimated. We call this the Tracking step.

The second step involves the creation of new hypotheses regarding new moving objects. That is, possible new objects are detected and their shape and motion are estimated. We call this the Detection step.

The final step decides on which, if any, of the hypotheses were correct. If any of the hypotheses are deemed valid, then we have identified a new moving object at this frame and this will now be tracked through subsequent frames. We call this the Validation step.

3. Technique(Algorithm Discription)

The effectiveness and feasibility of the proposed concept can be proven through analyzed the results on a real-life video sequence. The proposed work is depicted in the flow chart of fig.3.1 to understand the working methodology & steps of motion detection for current pair of frame. In this methodology a pixel variant plays a vital role in detection of moving frame of a particular clip. If there is a little bit motion in a file then it is detected very easily by tracking pixel variance.

3.1 SIMPLE DIFFERENCING MODEL METHOD

Moving object detection algorithms usually take two consecutive images as input and return the locations where differences are identified. These differences can be caused by the motion of an object, (including its entering and leaving the scene), changes in illumination or noise. The aim of such an algorithm is to locate only the changes that are due to structural changes in the scene, i.e. a moving object.

Moving object detection and extraction from the fixed background in the analyzed scene is mostly done by simple subtracting the current image and background image (that does not contain any moving objects).

The applied subtracting operation finds an absolute difference for each pixel, thus detecting moving objects (that have brighter or darker gray value), which usually differ from the background. If the difference is below a certain threshold, there is no change in the scene and the observed pixel is regarded as if it belongs to the background.

Otherwise, there has been a change and the pixel belongs to the moving object. The absolute subtracting algorithm can be presented by

IF $D = | C_m - B_m | > T$

          $O = 1$ (Object)

ELSE

          $O = 0$ (Background)

Where C_m is the value of the corresponding pixel intensity of the current image, B_m is the value of the corresponding pixel intensity of the background image, D is the absolute difference of the current and background image and O is

the binary difference image. T is the predefined threshold for image segmentation.

In the case of fixed threshold it can happen that a moving object with an average brightness, which is only slightly different than the background, cannot be detected. The value for threshold becomes very important because:

- If the threshold is too low, a sudden increase in background brightness due, for example, to a rapid change from overcast to sunshine, could cause a false detection.
- If the threshold is too high, a moving object with brightness close to the background will not be detected.

The optimal threshold value is usually determined by analyzing the histogram of difference image in a certain time interval, where the appearance of moving object in the scene causes the histogram of difference image to widen. However, this is a time consuming process that is not effective in real-time applications.

The main problem with difference technique is a variation in background brightness, mostly due to weather phenomena (clouds, rain, etc.) or artificial sources (illumination, car or plane headlights, shadows, etc.).

In order to make the background differencing technique more effective, the changes in ambient lighting must be compensated by some kind of background updating technique.

3.2 SHADING MODEL METHOD

The shading model method determines whether structural changes occurred in the scene. It is shown that the shading model method is superior to other techniques when the illumination is allowed to vary. The shading model method use the intensity of pixel I_P in the analyzed image according to:

$I_P = I_i S_P$

Where I_i is the illumination value and S_P is the shading coefficient. The main idea of the shading model is that it mathematically formulates the shading coefficient of every physical material, which is defined uniquely by the physical surface structure of the object and the reflectance of the surface material.

Unfortunately, it is not possible to calculate the shading coefficient for a given pixel without a priori knowledge of the surface structure. This task is very difficult, almost impossible to realize in real world applications. However, we do not need the exact value of the shading coefficient. We only need to detect a change in the shading coefficient to be able to indicate a change between the frames of the sequence. The shading model change detection algorithm uses the ratio of intensities recorded in a region of the two frames to detect this change.

It is expressed by

$$\sigma_i^2 = \frac{1}{Card\,\{A_i\}} \sum_{m \varepsilon Ai} \left[\frac{B_m}{C_m} - \mu_{Ai} \right]^2 \geq T$$

Where σ_i^2 is the variance of the intensity ratios, B_m is the background image that does not contain moving objects, C_m is the current frame of the scene, A_i is the observed region of interest of the processed image, card$\{A_i\}$ stands for the region size, T is predetermined threshold and μ_{Ai} is the average of the intensity ratio:

$$\mu_{Ai} = \frac{1}{Card\,\{A_i\}} \sum_{m \varepsilon Ai} \frac{B_m}{C_m}$$

Summation is performed pixel by pixel, over the region of interest. If there are changes in the physical surface in the observed region (all the shading coefficients do not change in exactly the same manner), the average of the ratios' variance in that region is greater than zero.

To determine whether a change has taken place in a given region, one simply calculates the σ_i^2 in that region. If it is close to zero (less than certain threshold), there have not been any structural changes in the scene. Otherwise, we assume a structural change had occurred (the moving object has appeared in the image). The region of interest A_i should be large enough so that the statistics is indicative of the nature of the region. This technique detects changes in physical surface structure and works well as long as the illumination changes are within ± 20% difference between background and current image. This method is not working for larger luminance changes. i.e. It is, roughly, illumination independent. This algorithm becomes again susceptible to luminance changes while the moving object is in the scene. If, for example, a cloud appears or disappears, illumination difference would cause significant changes in the ratio between corresponding pixels of background image and current picture. The shading model method is rather insensitive to noise.

3.3 PROPOSED MODEL METHOD

We noted that shading model method works well as long as the illumination changes are within ±20% difference between background and current image. This method is not working for larger luminance changes. Therefore in this method, we introduced the background updating technique in every frame that contains no moving objects in the scene. After the appearance of a moving object, background updating is locked out. This algorithm becomes again susceptible to luminance changes while the moving object is in the scene. If, for example, a cloud appears or disappears, illumination difference would cause significant changes in the ratio between corresponding pixels of background image and current picture.

This is the reason why we have introduced a modification to the existing method. We introduced a new coefficient Ki in variance of B_m/C_m that measures the ratio between average pixel intensity of the first frame when the moving object entered the scene and average pixel intensity of every current frame while the moving object is in the scene. We also used median value of intensity of all pixels that belong to the region Ai, instead of mean value of intensity ratio in the pixel variance calculation because this accelerates the whole algorithm. The comparison operation is faster than addition and division used for mean value calculation.

Consider image sequence I consisting of N video frames. The sliding mask Ai is applied on every frame. We calculate the pixel variance in order to estimate the potential movement in the observed area, as follows:

$$\sigma_i^2 = \frac{1}{\text{Card}\{A_i\}} \sum_{m \varepsilon A_i} \left[\frac{B_m}{C_m} K_i - \text{median}\{A_i\} \right]^2 \geq T$$

Where σ_i^2 is the pixel variance of current pair of frames, B_m is the pixel intensity within mask A_i for a reference background frame that does not contain moving objects, C_m is the pixel intensity for current frame of the scene (where we are identifying moving objects), A_i is the observed region of interest of the processed image, card$\{A_i\}$ stands for the region size, T is predetermined threshold which determines whether there is a structural change in the observed scene or not. The illumination compensation coefficient is defined as:

$K_i = 1$ (The beginning coefficient value)

$$\sigma_i^2 = \frac{1}{\text{Card}\{A_i\}} \sum_{m \varepsilon A_i} \left[\frac{B_m}{C_m} K_i - \text{median}\{A_i\} \right]^2 \geq T$$

$$\text{THEN} \quad K_i = \frac{\sum_{m \varepsilon A_i} C_m}{\sum_{m \varepsilon A_i} C_{1m}} = \frac{\mu_i}{\mu_1}$$

ELSE Ki = 1

Where C_{1m} is pixel intensity for the first frame in the sequence, μ_i is the average of pixel intensity with in mask Ai for the current frame while the moving object is present in the scene, μ_1 is the average of pixel intensity with in mask A_i of the first frame after the moving object entered the scene.
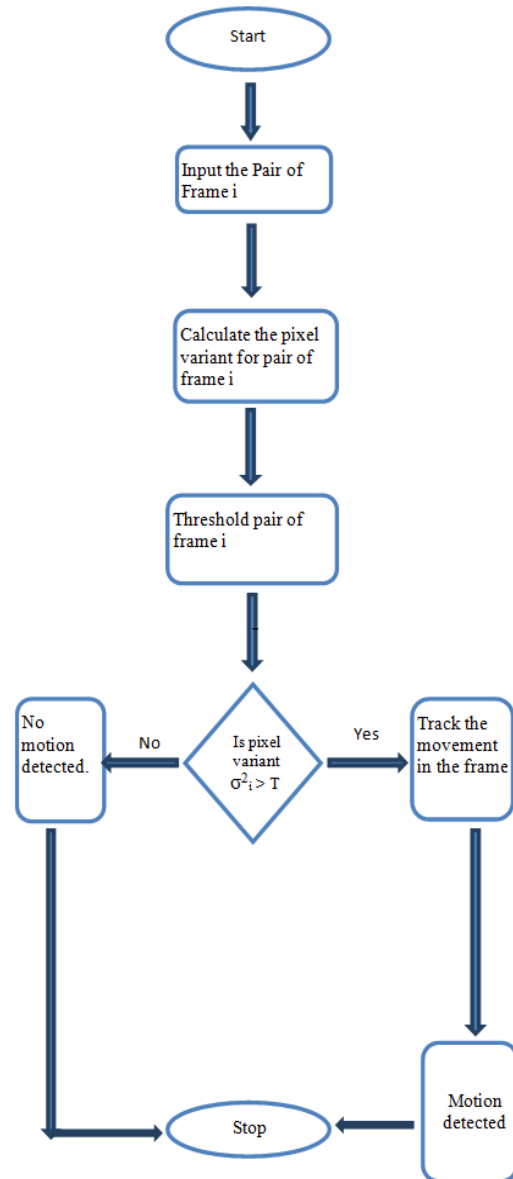

Fig. 3.1 Flow Chart of Proposed Algorithm

The algorithm performs the analysis in time and space domains simultaneously, contributing to its resistance to the illumination changes and reducing the false detection. We calculate the pixel variance in order to estimate the potential observation for current pair of frame i and threshold this value to determine the presence of moving objects. This represents temporal aspect of analysis. If the pixel variant value of current pair of frame i is greater than zero (T Threshold) then the motion is detected in the frame of moving clip i.e. it is assumed that the moving object entered the observation window.

$\sigma_i^2 > 0$ (T Threshold)

At that moment, we memorize the average value of the first window μ_1 just one frame before the moving object

entered the scene so that it would not contain a contribution from the moving object. In this methodology a pixel variant plays a vital role in detection of moving object in a particular clip. If there is a little bit motion above the predefined threshold in a frame then it is detected very easily by tracking pixel variance.

Thus this algorithm detects the zero variation only when the movements in object are below the threshold value. Furthermore we can also compare the rate of change of motion in successive pair of frames. If ($\sigma_i^2 > \sigma_{i-1}^2$), rate of change of motion on current pair of frame will be more than previous pair of frame. If ($\sigma_i^2 = \sigma_{i-1}^2$), rate of change of motion on current pair of frame & previous pair of frame will be same.

Working Methodology & Steps of Flow Diagram –

a) Start
b) Input the pair of frame i sequence of N video frames, like the sliding mask Ai is applied on every frame.
c) Calculate the pixel variant in order to estimate the potential observation for pair of frame i.
d) Thresholds the pair of frame i to determine the presence of moving object.
e) If the pixel variant value of current pair of frame i is greater than zero (T) then the motion is detected in the frame of moving clip. Otherwise detects the zero variation only when there is no motion in a pair of frame.
f) Track the movement in the current pair frame i.
g) Hence the motion is detected.
h) Stop

4. EXPERIMENTAL RESULTS

The effectiveness and feasibility of proposed concept has been proven through the experimental results given in below table and graph for a real-time video sequence. From the experimental data, we clearly explain that the change in pixel Variance means motion had occurred from the current frame to previous frame. We also inferred if the pixel variant is zero from the current to previous frame then no motion had occurred.

Table 4.1 Pixel variance value of pair of frames for moving hands of sliding clip

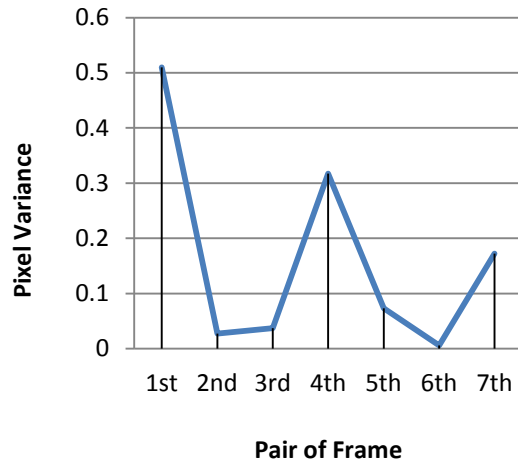| Pair of Frame	Pixel Variant (σ)	Frames
1st	0.510	first167-76-830　second167-76-830
2nd	0.027	first177-79-881　second177-79-881
3rd	0.037	first186-76-527　second186-76-527
4th	0.317	first196-82-565　second196-82-565
5th	0.073	first202-82-19　second202-82-19
6th	0.006	first204-85-854　second204-85-854
7th	0.172	first218-74-542　second218-74-542

Fig 4.2 Graph for motion detection

3. Conclusion

In this paper a new approach is proposed for motion detection by analyzing the difference of two successive frames with the help of pixel variance using the tracking, detection and validation method. If there is a little bit motion above the predefined threshold in a pair of frame then it will be detected very easily by pixel variance. We enhance the efficiency of tracking the motion by implementing pixel base displacement algorithm in the frame of object as the current and previous, strongly focused in the advancement of intelligent video surveillance system. In this work we introduced a new illumination compensation coefficient Ki in variance of $_{Bm}/C_m$ that measures the ratio between average pixel intensity of previous method i.e. it is illumination independent method. We also used median value of the observed region A_i, instead of mean value in calculating the variance because the comparison is faster than addition and division (necessary for calculating the mean value). However there have some limitations as:

When σ_i^2 becomes less than predetermined threshold T, it means there are no moving objects in the observed scene, so the coefficient K_i is set to 1, therefore a background updating method will require again and there is no need for compensation using coefficient Ki.

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