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MOTION DETECTION USING BACKGROUND SUBTRACTION FOR VIDEO SURVEILLANCE

M. Baby Sakunthala, V. Lakshmi Praba

Department of Computer Science, Rani Anna Government College for Women, Tirunelveli
(e-mail: sakunthalamuthukrishnan@rediffmail.com)

Abstract: *This project presents moving object detection based on background subtraction under complex wavelet transform domain for video surveillance system. The object detection in frequency domain will be approached to segment objects from foreground with absence of background noise. Initially it starts with background initialization by choosing start frame or taking initial few frames with approximate median method. Then, complex wavelet transform is applied to both current and initialized background frame generates subbands of low and high frequencies. Frame differencing will be done in this subbands followed by edge map creation and image reconstruction. In order to remove some unwanted pixels, morphological erosion and dilation operation is performed for object edge smoothness. The proposed approach has some advantages of background noise insensitiveness and invariant to varying illumination or lighting conditions. It also involves background updating model based on current frame and previous background frame pixels comparisons. After the object detection, performance of method will be measured (between frame ground truth and obtained result) through metrics such as sensitivity, accuracy, correlation and peak signal to noise ratio. This object detection also helps to track detected object using connected component analysis. The simulated result shows that used methodologies for effective object detection has better accuracy and with less processing time consumption rather than existing methods.*

Keywords: Complex wavelet transform, Morphological erosion & dilation, Object edge smoothness.

1. Introduction

1.1 Video Surveillance System

The Video Surveillance System has come into day-to-day life and it has been widely applied to several places, such as supermarkets, banks, schools, museums, and few others. My goal is to find a simple method to realize the real-time detection of the moving objects, so as to apply it to the intelligent surveillance system. At present, there are three mainly used conventional approaches to moving objects detection: temporal differencing, background subtraction, and optical flow. In many surveillance applications, background subtraction has been used extensively to detect the foreground regions however, a common problem of background subtraction is that it requires a long time for estimating the background models. Temporal differencing is more effective in the case that the moving objects are obviously different from the background and moving relatively fast. Temporal differencing could rapidly detect the possible moving objects and be adapted to the changing lightening. Optical flow provides all motion information. But optical flow computation methods are too complex to use in real-time applications if without special hardware.

1.2 Moving object detection

The moving object detection is an important task within the image sequences of the area which is under surveillance. in proposed system the digital camera is used for tacking the video of the area. Basically there are three techniques which are used for the motion detection in the sequence of the images such as temporal difference, optical flow and background subtraction algorithm. Out of these background subtraction algorithms is used. This algorithm will subtract the background from the frame to get the moving object in the frame. The idea of background subtraction is to subtract or find the difference between the current images from a reference background model. First of all, establish a reliable background updating model based on statistical and use a dynamic optimization threshold method to obtain more complete moving object detection.

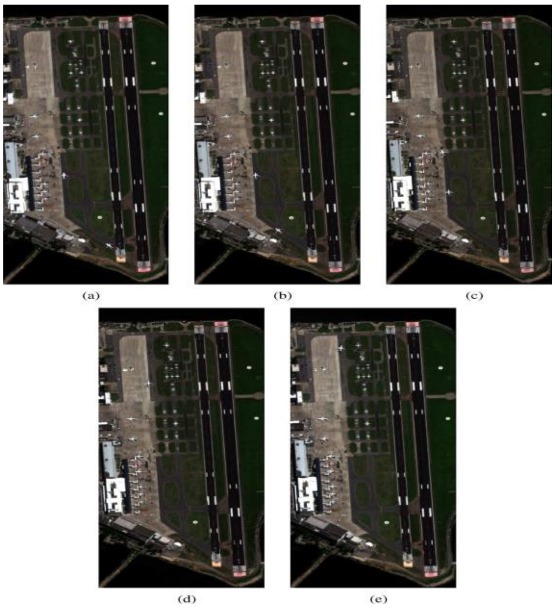


Fig. Subset of five frames collected over an airport region at different

2. Literature Survey

The importance and popularity of motion analysis has led to several previous surveys:

Shafie et al. presented motion detection using optical flow method. Optical flow can arise from the relative motion of objects and the viewer so it can give important information about the spatial arrangement. Discontinuities in the optical flow can help in segmenting images in to regions that correspond to different objects.

Devi et al. presented motion detection using background frame matching. This method is very efficient method of comparing image pixel values in subsequent still frames captured after every two seconds from the camera. Two frames are required to detect movement. First frame is called reference frame and the second frame, which is called the input frame contains the moving object. The two frames are compared and the differences in pixel values are determined.

Lu et al presented motion detection by proposing a real time detection algorithm. In this the algorithm integrates the temporal differencing method, optical flow method and double background filtering (DBF) method and morphological processing methods to achieve better performance.

3. System Analysis

3.1 Temporal differencing

The Frame differencing method uses the two or three adjacent frame based on time series image to subtract and gets difference images, its working is very similar to background subtraction after the subtraction of image it gives moving target information through the threshold value. This method is [3,4] simple and easy to implement, and also it is similar to the background subtraction. But this method is highly adaptive to dynamic scene changes, however, it generally fails in detecting whole relevant pixels of some types of moving objects. Additional methods need to be adopted in order to detect stopped objects for the success of higher level are computationally complex and cannot be used real-time without specialized hardware.

3.2 Optical flow Method

The optical flow method uses the motion target of the vector characteristics which changed with time to detect motion area in image sequences. The computation of differential optical flow is, essentially, a two-step procedure:

1. Measure the spatio-temporal intensity derivatives (which is equivalent to measuring the velocities normal to the local intensity structures) and
2. Integrate normal velocities into full velocities, for example, either locally via a least squares calculation or globally via a regularization.

In optical flow, a motion vector of each pixel is computed and entire image could be imagined as a vector field. The motion vector of each pixel represents the brightness of the pixel. The region of the image where brightness change is observed is considered as a candidate for moving object. The method based on optical flow is complex, but it can detect the motion accurately even without knowing the background. This approach results in good performance, however this algorithm need one more than image to be stored, thus resulting in higher memory requirements, in-turn resulting in high cost.

3.3 Frame subtraction method

Detection of moving object from a sequence of frames is captured from a static camera which is widely performed by frame difference method. The task of this approach is to detect the moving objects from the difference between the current frame and the reference frame. The frame subtraction method is commonly used method for detection of motion. This method adopts pixel by pixel based difference to find the moving object. In the frame subtraction method the presence of moving objects is determined by calculating the difference between two consecutive images.

- Gradual variations of the lighting conditions in the scene
- Small movements of non - static objects such as tree branches and bushes blowing in the wind
- Shadow regions are projected by foreground objects and are detected as moving objects.

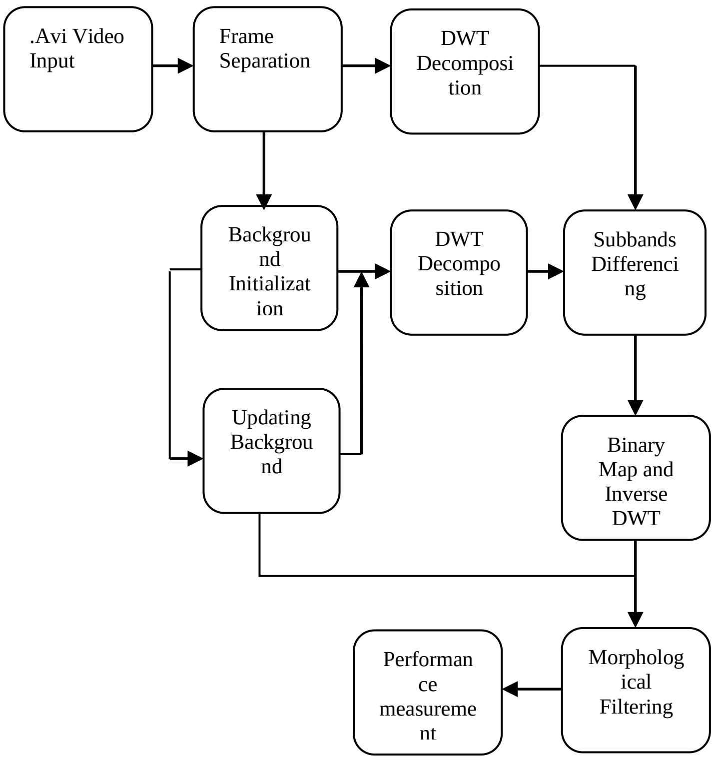
3.4 Double Background Filtering

By using the optical flow method, two types of optical flow information are obtained, which are the interference information of image background and the information of image pixel with any possibility of real object movement. In the real situation, because of the environment such as light, vibration and so on, the interference information of the back ground still can be detected. Sometimes, it is difficult for the real object movement to be differentiated from the background interference.

This approach is based on a double background principle, long-term background and short -term background. For the long-term background, the background interference information which has happened in a long time is saved. For the short-term background, the most recent changes are saved. These two background images are modified to adequately update the background image and to detect and correct abnormal conditions.

4. Proposed Methods

4.1 Block Diagram



Proposed algorithm can be explained as follows:

1. Input a video
2. Extract the frame
3. Take absolute difference of the current image and a background image.
4. Select proper threshold level to convert subtracted image into binary image.
5. Convolve proposed 3 x 3 masks with binary image to filter our noise.
6. B(x,y)=1 represent foreground
7. B(x,y)=0 represent background
8. Find a performance measurement
9. Use a Morphological Filtering

4.2 Motion detection

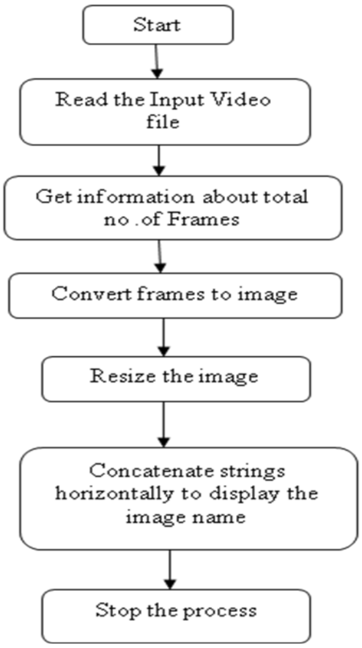
The most fundamental type of motion detection is the technique for subtracting know background image containing no objects from an image under test. There are a few routines to background subtraction, including averaging background frames overtime and measurable displaying of every pixel. Preprocessing based on mean filtering is done on the input video (i.e.,image groupings) to even out the light brightening changes and also to suppress the presence of shadows.

4.3 Frame Separation

Frame separation is the foremost step in motion detection. Actually the input is given to the entire network in the form of a movie. Next the frames are separated from the input movie and changed over mages. This process includes store the input movie (.avi file), fix the data about the no. of frames, width and stature the frame, image quality etc.

- An Input Video(.avi files) are converted into still images for processing it and detect the moving objects.
- These sequence of images gathered from video files by finding the information about it through ‘aviinfo’ command.
- These frames are converted into images with help of the command ‘frame2im’

Create the name to each images and this process will be continued for all the video frames



4.4 Image preprocessing

Image preprocessing is the primary assignment in moving object detection. The small changes in the pixel lead to false location. Noise can be added because of different reasons. Due to the noise the pixel values might be changed. So image preprocessing is extremely key.

A. Noise Removing

Noise is any entity which is not of benefit to the purpose of image processing. The impact of noises on the image signal amplitude and phase is complexity. So how to smooth out noise and keep the points of interest of image are the real errands of image filtering.

B. Noise Filter

Median filter is a nonlinear system for removing noise. Its fundamental thought is to use the median of the neighborhood pixel gray value instead of the gray value of pixel point. For the odd components, the median refers to the size of the middle value after sorting. Median filter as a result of this method is not dependent on the neighborhood with a lot of difference between typical values, which can remove impulse noise, salt and pepper noise at the same time retain the image edge details. In general the use of a median filters contain odd numbered points of the sliding window. Specific methods are determined first add numbered pixel window W. Each pixels in window line with the size of the gray value and use the location of the gray value between the image f (x, y) gray value as a substitute for enhanced images g (x, y) as follows.

g(x,y)=Med{f(x-k,y-l), (k,l) ∈ W

W is the window which is selected

4.5 Discrete Wavelet Transform

The discrete wavelet transform (DWT) was developed to apply the wavelet transform to the digital world. Filter banks are used to approximate the behavior of the continuous wavelet transform. The signal is decomposed with a high-pass filter and a low-pass filter. The coefficients of these filters are computed using mathematical analysis and made available to you.

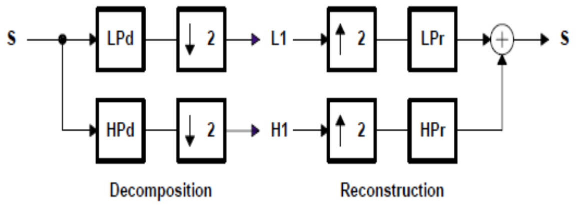


Figure 4. Discrete Wavelet Transform

Where

LPd: Low Pass Decomposition Filter

HPd: High Pass Decomposition Filter

LPr: Low Pass Reconstruction Filter

HPr: High Pass Reconstruction Filter

4.6 Background subtraction

Background subtraction is a computational vision process of extracting foreground objects in a particular scene. A foreground object can be depicted as an object of consideration which helps in reducing the amount of data to be processed and in addition give critical data to the assignment under consideration. Often, the foreground object can be thought of as an intelligibly moving article in a scene. We must accentuate the word coherent here because if a person is walking in front of moving leaves, the individual structures the closer view object while leaves though having motion associated with them are considered foundation because of its dull conduct. In some cases, distance of the moving object also forms a premise for it to be viewed as a foundation.

4.7 Thresholding

A straightforward division procedure that is extremely helpful for scenes with solid objects resting on a contrasting background. All pixels over a decided (threshold) grey level are assumed to belong to the object, and all pixels below that level are thought to be outside the item. The determination of the threshold level is very important; as it will affect any estimation of parameters concerning the object (the exact object boundary is very sensitive to the grey threshold level picked). Thresholding is regularly done on images with bimodal distributions. This is explained below. The best limit level is ordinarily taken as the most reduced point in the trough between the two peaks (as above) alternatively; best limit level is ordinarily taken as the most reduced point. Figure 4 below illustrates the application of a thresholding algorithm on a sample image. It obviously distinguishes the objects of interest in the image, and removes any noise present.

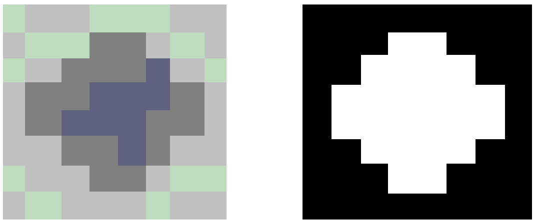


Figure 4 Thresholding Application

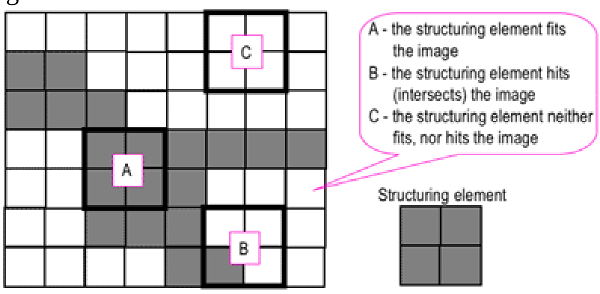
4.8 Object tracking

Once the object areas are determined in every edge, the following is performed to follow the objects from frame to frame. The color information from each blob is determined and matching so as to follow is performed blob shading. To handle occlusion, each motion blob is the key feature of proposed strategy is the shading Information of each object is extracted cluster-by-cluster. Each cluster has its own weight for comparison. The color information is extracted from the motion blocks in the current frame to categorize coordinating shading data between movement hinders in the current frame and previous frames. Subsequently, a tag is assigned to the motion blocks in the current frame.

4.9 Morphological Filtering

Morphological image processing is a collection of non-direct operations identified with the shape or morphology of features in an image. Morphological operations rely only on the relative requesting of pixel qualities, not on their numerical values, and therefore are especially suited to the processing of parallel pictures. Morphological operations can likewise be connected to grey scale images such that their light transfer functions are obscure and in this way their outright pixel qualities are of no or minor interest.

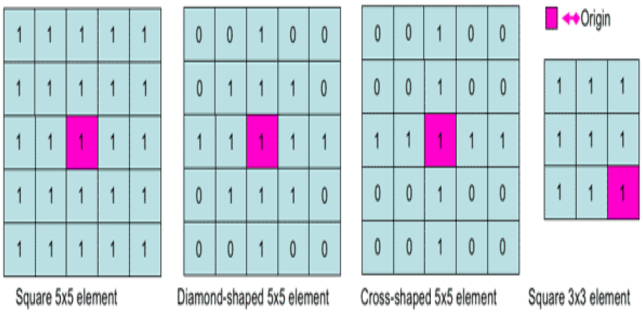
Morphological techniques probe with a little shape or layout called a structuring element. The structuring element is positioned at all possible areas in the picture and it is contrasted and the comparing neighbourhood of pixels. Some operations test whether the component "fits" inside of the area, while others test whether it "hits" or intersects the neighbourhood:



Probing of an image with a structuring element

The structuring element is a small binary image, i.e. a little network of pixels, each with an estimation of zero or one:

- The matrix dimensions specify the size of the structuring element.
- The pattern of ones and zeros specifies the shape of the structuring element.
- An origin of the structuring element is usually one of its pixels, although generally the origin can be outside the structuring element.



4.10 Fundamental operations

More formal descriptions and examples of how basic morphological operations work is given in the Hypermedia Image Processing Reference (HIPR) developed by Dr. R. Fisher et al. at the Department of Artificial Intelligence in the University of Edinburgh, Scotland, UK.

4.10.1. Erosion and dilation

The **erosion** of a binary image *f* by a structuring element *s* (denoted $f \ominus s$) produces a new binary image $g = f \ominus s$ with ones in all locations (*x*,*y*) of a structuring element's origin at which that structuring element *s* fits the input image *f*, i.e. $g(x,y) = 1$ is *s* fits *f* and 0 otherwise, repeating for all pixel coordinates (*x*,*y*).

Greyscale image

Binary image by thresholding

Erosion:a2×2 square structuring element

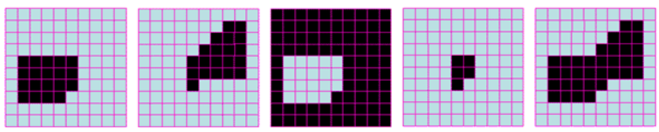
The dilation of an image f by an organizing component s (meant f s) creates new binary image g = f s with ones in all locations (x,y) of a structuring element's origin at which that structuring element s hits the the input image f, i.e. g(x,y) = 1 if s hits f and 0 generally, rehashing for all pixel facilitates (x,y). Dilation has the opposite effect to erosion -- it adds a layer of pixels to both the inward and external boundaries of regions.

Binary image

Dilation: a 2×2 square structuring element

4.10.2 Compound operations

Many morphological operations are represented as combinations of erosion, dilation, and simple set-theoretic operations such as the complement of a binary image:



Set operations on binary images: from left to right: a binary image f, a binary image g, the complement f^c of f, the intersection $f \cap g$, and the union $f \cup g$.

The opening of an image f by a structuring element s (denoted by $f \circ s$) is an erosion followed by a dilation:

$f \circ s = (f \ominus s) \oplus s$

5. Parameter evaluation

Peak –signal-to noise ratio and Mean square error

Human eyes perception is the fastest approach. However, although this criterion is effective in general, the results may differ from person to person. To establish an objective criterion for digital image quality, a parameter named PSNR (Peak Signal to Noise Ratio) is defined in equation 3.8 as follows:

$$PSNR = 10*\log10\,(255*255/MSE)$$

where MSE (Mean Square Error) stands for the mean-squared difference between the cover-image and the stego-image. The mathematical definition for MSE is defined in equation 3.9 as follows:

$$MSE=1/(M*N)\sum_{i=1}^{M}\sum_{j=1}^{N}(a_{ij}-b_{ij})^2$$

In this above equation a_{ij} means the pixel value at position (i,j) in the input image and b_{ij} is the pixel value at the same position in the output image. The calculated PSNR usually adopts dB value for quality judgement. The larger PSNR is, the higher the image quality is (which means there is only little difference between the input-image and the fused-image). On the contrary, a small dB value of PSNR means there is great distortion between the input-image and the fused-image.

Correlation Coefficient: It gives similarity in the small structures between the original and reconstructed images. Higher value of correlation means that more information is preserved. Coefficient correlation in the space domain is defined by:

*Correlation = sum (sum (B.*A))/Sqrt (sum (sum (B.*A))*sum (sum (A.*A)));*

Where, B is difference between fused image and its overall mean value.

A is difference between source image and its overall mean value.

6. Conclusion

In this work, Background subtraction algorithm based motion detection using a MATLAB coding. Improving segmentation results as well as being able to extract additional information such as frame deference, background subtraction allows for improved object detection and thus tracking. The subtraction of the two image is gives the good results of the moving object in the surveillance area. The resultant subtracted frame contains the information or data from both the input frames. It provides an effective way of detecting moving object. It will give better information of the moving object in video as compared to another algorithm.

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