International Journal of Scientific Engineering and Research (IJSER)
www.ijser.in
ISSN (Online): 2347-3878, Impact Factor (2014): 3.05

Human Motion Detection and Video Surveillance Using MATLAB

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Abstract: ***A human body detection algorithm based on the combination of moving information with shape information is proposed in the paper. Firstly, Eigen-object computed from three frames in the initial video sequences is used to detect the moving object. Secondly, the shape information of human body is used to classify human and other object. Furthermore, the occlusion between two objects during a short time is processed by using continues multiple frames. The advantages of the algorithm are accurately moving object detection, and the detection result doesn't effect by body pose. Moreover, as the shadow of moving object has been eliminated.***

Keywords: Moving object detection, Background subtraction, Background model

1. Introduction

There are three types of methods mainly used in moving object detection. These methods are the frame subtraction method, the background subtraction method and the optical flow method [1]. In the Frame subtraction method [2] the difference between two consecutive images is taken to determine the presence of moving objects. The calculation in this method is very simple and easy to develop. But in this method it is difficult to obtain a complete outline of moving object; therefore the detection of moving object is not accurate. In the Optical flow method [1], calculation of the image optical flow field is done. The clustering processing is done according to the optical flow distribution characteristics of image. From this, the complete movement information of moving body is found and it detects the moving object from the quantity of calculation, poor anti-noise performance makes it unsuitable for real-time applications. The background subtraction method [2] is the method in which the difference between the current image and background image is taken for the detection moving objects by using simple algorithm. But it is very sensitive to the changes which occur in the external environment and it also has poor anti interference ability. One advantage of this method is, it can provide the most complete object information in the case of the background is known [3]. In the background subtraction method, in a single static camera condition, the dynamic background modeling is combined with dynamic threshold selection method which depends on the background subtraction. The background is updated on the basis of accurate detection of object.

A) Frame Separation

Frame processing [4] is the first step in the background subtraction algorithm, the purpose of this step is to prepare the modified video frames by removing noise and unwanted objects in the frame in order to increase the amount of information gained from the frame. Preprocessing of a image is a process of collecting simple image processing tasks that change the raw input video info into a format. This can be processed by subsequent steps. Preprocessing of the video is necessary to improve the detection of moving object's, For example; by spatial and temporal smoothing, snow as moving leaves on a tree, can be removed by morphological processing of the frames after the identification of the moving object.

B) Moving Object Detection

Background subtraction is particularly a commonly used technique for motion segmentation in static scenes [2]. It attempts to detect moving regions by subtracting the current image pixel-by-pixel from a reference background image that is created by averaging images over time in an initialization period. The pixels are classified as foreground where the difference is above a threshold. After creating a foreground pixel map, some morphological post processing operations such as erosion, dilation and closing are performed to reduce the effects of noise and enhance the detected regions. The reference background is updated with new images over time to adapt to dynamic scene changes. There are different approaches to the basic scheme of background subtraction in terms of foreground region detection, background maintenance and post processing. In [5] Heikkila and Silven uses the simple version of this scheme where a pixel at location (x, y) in the current image, it is marked as foreground if is satisfied.

$$|It(x, y) – Bt(x, y)| > \tau \text{ -----------------------1}$$

Where, τ is a predefined threshold. The background image Bt is up- dated by the use of an Median filter as follows:

$$Bt+1 = \alpha It + (1 - \alpha) Bt\text{----------------------2}$$

The foreground pixel map creation is followed by morphological closing and the elimination of small-sized regions. Although background subtraction techniques perform well at extracting most of the relevant pixels of moving regions even they stop, they are usually sensitive to dynamic changes when, for instance, stationary objects uncover the back- ground (e.g. a parked car moves out of the parking lot) or sudden illumination changes occur.

a) Background Modeling

In the background modeling process [6], the reference background image and some parameters associated with normalization are computed over a number of static background frames. The background is modeled statistically on a pixel by pixel basis. A pixel is modeled by a 4-finite sequence of pixels Ei; si; ai; bi where Ei is the expected color value, si is the standard deviation of color value which is defined in ai is the variation of the brightness distortion, and bi is the variation of the chromaticity distortion of the i^{th} pixel. The expected color value [6] of pixel i is given by

$$Ei = [\mu R(i), \mu G(i), \mu B(i)]\text{----------------3}$$

Where $\mu R(i)$, $\mu G(i)$ and $\mu B(i)$ are the arithmetic means of the ith pixel's red, green and blue values computed over N background frames. So far, we have defined Ei and si.

b) Background Update

For accurately extracting the moving object the background needs to be updated in real time and the background model can better adapt to light changes. In the proposed method, the update algorithm is as follows: In the moving object detection, the pixels judged as belonging to the moving object maintain the original background gray values, not be updated. We update the background model according to following rule for the pixels which are judged to be the background [3]

$$B_{k+1}(x,y) = \beta B_k(x,y) + (1-\beta) F_k(x,y) \text{ --------------4}$$

Where B(x,y) is background image, Fk(x,y) is current image and F3 E **(0,1)** is update coefficient, in this paper f3 = 0.004. $F_k(x,y)$ is the pixel gray value in the current frame. $B_k(x,y)$ and $B_{k+1}(x,y)$ are respectively the Background value of the current frame and the next frame. As the camera is fixed, the background model can remain relatively stable at one position for very long period of time. Using this method we can avoid the unexpected phenomenon of the Background, such as the sudden appearance of something in the background which is not included in the original background. Moreover, the impact brought by light, weather and other changes in the external environment can be effectively adapted by the updating of pixel gray value of the background.

c) Moving Object Extraction

When the background image B(x, y) is obtained, subtract the background Image B(x,y) from the current frame Fk (x, y). Set threshold as T. If the pixel difference is greater than threshold T, then determines that the pixels appear in the moving object, otherwise, as the background pixels. The moving object can be detected after threshold operation [3]. Its expression is as follows:

Dk (x, y) = {1 | Fk(x,y) – Bk-1(x,y)| T ---------(5)

={0 others Where, Dk (x, y)

is the binary image of differential results. T is gray-scale threshold. Its size determines the accuracy of object identification. As in the algorithm T is a fixed value, only for an ideal situation, is not suitable for complex environment with lighting changes. Therefore, this paper proposes the dynamic threshold method, we dynamically changes the threshold value according to the lighting changes of the two images obtained. On this basis, add a dynamic threshold T to the above algorithm.

d) Extraction of Moving Human Body

Some accurate edge regions are got after doing the median filtering and morphological operations. But the moving human body regions could not be determined. By observation, we can find out that when moving object appears, shadow will appear in some regions of the scene. The presence of shadow it is difficult to extract the moving object accurately. By analyzing the characteristics of motion detection, we combine the projection operator with the previous methods [6]. Based on the results of the methods above, adopting the method of combining vertical with horizontal projection to detect the height of the motion region. This can remove the impact of the shadow to a certain degree. Then we analyze the vertical projection value and set the threshold value (determined by experience) to remove the pseudo-local maximum value and the pseudo-local minimum value of the vertical projection [7] to determine the number and width of the body in the motion region, we will get the moving human body with precise edge. We are assuming that people in the scene are all in upright-walking state.

C) Detection of Moving Objects in the Video

Motion detection has been done using spatio-temporal differencing. For motion detection based on the spatio-temporal filter, the motion is characterized via the entire three-dimensional (3D) spatio-temporal data volume spanned by the moving person in the image sequence. Its advantages are low computational complexity and a simple implementation process. Here, Motion detection is carried out by the background elimination algorithm as follows.

D) Background Elimination

The background subtraction system is used to provide foreground image through thethreshold of difference image between the current image and reference image. As the reference image is the previous frame, this method is called temporal differencing. The temporaldifferencing is very adaptive to dynamic environment. Background elimination was carried outusing mean squared error concept.

2. Proposed Methodology

A) Algorithm for background Elimination

1. Begin
2. Read video using*mmreader*command in MATLAB.
3. Extract number of frames, height and width of frames.
4. Pre-allocate output video structure with all its elementsassigned value 0.
5. Divide each frame into blocks of size 16x16 each.
6. Compare blocks of first frame with the corresponding blocks of each frame using meansquared error(MSE) concept.
7. If MSE is less than 5 percent the blocks are considered to be matched.
8. If more than half the corresponding blocks match, the blocks are considered to be a partof background and are made white in the output video structure.
9. If none or less than half the number of corresponding blocks does not match, they are considered to be moving object and original video values are assigned to those blocks inthe output video structure.
10. The output video now contains only the moving object and background is eliminated.
11. End

B) Human Detection from background eliminated video

A shape-based approach for classification of objects is used following background subtraction based on frame differencing. The goal is to detect the humans for threat assessment. The target intruder is classified as human or animal or vehicle based on the height to width ratio (H/W) of the moving object detected during background subtraction.

a) Algorithm for human detection

1. Begin
2. Read the original and background eliminated videos using *mmreader*function in MATLAB.
3. Extract the number of frames and frame size.
4. Pre-allocate output video structure assigning zeros to all its elements.
5. Make the pixels corresponding to moving object white and the rest black.
6. For each frame number of blocks containing moving object are checked to satisfy H/W ratio depending on area covered by camera.
7. Draw top, bottom, left and right lines in red color to highlight the detected human.
8. End

3. Applications

For an intelligent video surveillance system, the detection of a human being is important for abnormal event detection, human gait characterization, people counting, person identification and tracking, pedestrian detection, gender classification, fall detection of elderly people, etc.

a) Abnormal event detection:

The most obvious application of detecting humans in surveillance video is to early detect an event that is not normal. Abnormal events can be classified as single-person loitering, multiple-person interactions (e.g. fighting and personal attacks), person-vehicle interactions (e.g. vehicle vandalism), and person-facility/location interactions (e.g. object left behind and trespassing).

b) **Human gait characterization:**

Detection of humans in walking can be carried out by extracting double helical signatures (DHS) from surveillance video sequences. DHS is robust to size, viewing angles, camera motion and severe occlusion for simultaneous segmentation of humans in periodic motion and labeling of body parts in cluttered scenes.

c) Person detection in dense crowds and people counting:

Detecting and counting persons in a dense crowd is challenging due to occlusions. Multiple height homo-graphics for head top detection can be used to overcome this problem. Advantage of the stationary cameras to perform background subtraction and jointly learn the appearance and the foreground shape of people in videos can be taken.

d) Person tracking and identification:

A person in a visual surveillance system can be identified using face recognition and gait recognition techniques. The detection and tracking of multiple people in cluttered scenes at public places is difficult due to a partial or full occlusion problem for either a short or long period of time.

e) Pedestrian detection:

Pedestrian detection is another important application of human detection. A pedestriandetection system can be described by integrating image intensity information with motion information. The detector can be built over two consecutive frames of a video sequenceand can be based on motion direction filters, motion shear filters, motion magnitude filters and appearance filters.

f) Fall detection for elderly people:

Automatic detection of a fall for elderly people is one of the major applications of humandetection in surveillance videos. Projection histograms of segmented human body silhouette can be used as the main feature for vector posture classification and the speed of fallcan be used to differentiate real fall incident and an event where a person is simply lyingwithout falling.

g) Consumer Surveillance System:

Automatic surveillance requires a sufficiently high accuracy and the computation complexity should enable a real-time performance. For such a system, we need to analyze notonly the motion of people, but also the posture of the person, as the postures of the persons can provide important clues for the understanding of their activities. Hence, accuratedetection and recognition of various human postures contribute to the scene understanding.

4. Conclusions and Results

A video monitoring detecting system was thus developed successfully in this project. This system mainly provides an efficient method for surveillance purposes and is aimed to be highly beneficial for any person or organization. Thus motion based change detection in .avi video format was completed and successfully implemented. I propose an instance based method for human detection in videos, which is motivated by a range of applications. An implementation and system design of a prototype system developed for testing purposes is reviewed in this report as well. In this paper, a human body detection algorithm based on the combination of temporal information and shape information is designed. Firstly, moving objects are detected using the proposed background elimination technique. Secondly, shape information is used to distinguish human body and other moving object and the outside rectangle of moving object is computed using the max width and height value of the moving regions.Furthermore, occlusion during a short time is handled by detecting the shape of moving object in continues frames. The evaluation cases shows the accurate detection of moving object and the detection result do not effect by the body pose. Also, the shadow of moving object has been eliminated in detection step, thus human can be detected.

Overall efficiency= (Successful cases/Total no. of cases) ×100

Overall efficiency (%)=7/9×100

Overall efficiency (%)=77.78%

Overall Efficiency of the project is about 77.78%, i.e., most of cases gave the successful result by the proposed detection algorithm. The algorithm is robust to noise and can detect the human bodies under complex circumstance.

Table 1: Analysis of different cases

Case No.	*Case*	*Fail/ Success*
1	Single person case	Successful
2	Body pose change(standing to sitting) Successful	Successful
3	Two person crossing case Successful	Successful
4	Front crossing case Successful	Successful
5	Half body detection case Successful	Successful
6	Multiple persons case Successful	Successful
7	Shadow Eliminations a] Horizontal Shadow Successful b] Vertical Shadow Failed	Successful Failed
8	Moving camera Failed	Failed

Figure 1: Original Video

Figure 2: Back ground elimination

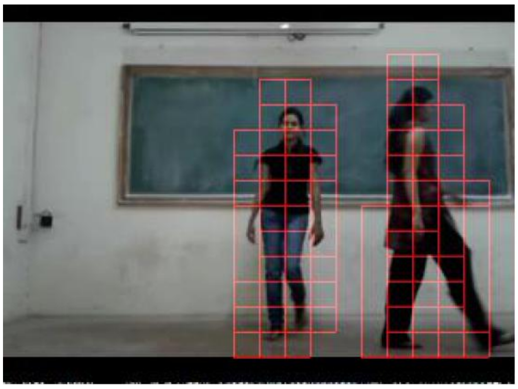

Figure 3: Human Detected

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