Human Motion Detection using Background Subtraction Algorithm

R.S.Rakibe[*]   **Prof.B.D.Patil**
ME(Student), Department of E&TC   *Assistant Professor, Department of E&TC*
Engg,GHRCEM, Pune, India   *Engg,GHRCEM, Pune, India*

Abstract— Visual analysis of human motion is currently one of the most active research topic in computer vision. In which the moving human body detection is the most important part of the human body motion analysis, the purpose is to detect the moving human body from the background image in video sequences, and for the follow-up treatment such as the target classification, the human body tracking and behavior understanding, its effective detection plays a very important role. Human motion analysis concerns the detection, tracking and recognition of people behaviors, from image sequences involving humans. According to the result of moving object detection research on video sequences, this project presents a new algorithm for detecting moving objects from a static background scene, to detect moving object based on background subtraction. We set up a dynamic threshold method to minimize the effect of illumination. After that, median filtering is initiated to remove the noise and solve the background interruption difficulty then the moving human bodies are accurately and reliably detected. The experiment results show that the proposed method runs rapidly, exactly and fits for the real time detection.

Keywords— Background subtraction, Background model, Moving object detection.

I. INTRODUCTION

VIDEO surveillance systems are used in both public and private sectors. They have significant implications in the defence against criminality and terrorist threats. Understanding of human activity from a video is an important stream of research within computer vision which has achieved a lot of importance in the last few years. The growing interest in human motion analysis is strongly motivated by recent improvements in computer vision, the accessibility of low-price hardware such as video cameras and different new challenging applications such as personal identification and visual observation. It can without human intervention estimate the motion of a person or a body part from monocular or multi-view video images.   Human body motion analysis has been an interesting research for its various applications, such as virtual reality, medical diagnostics, physical performance, human–machine interface, and evaluation. In general, three aspects of research directions are tracking and estimating motion parameters, analysing of the human body structure, and recognizing of motion activities. These are considered in the analysis of human body motion.

Intelligent vision analysis has been one of the key technologies in intelligent environment, security monitoring and human computer interaction. Detecting moving objects is the basis of this technology [1][2]. Detecting the moving objects relative to the whole image is the major task of it. Detecting moving objects is the foundation of other advanced applications, such as target tracking, targets classification and target behaviour understanding. Optical flow, frame difference and background subtraction are major three methods of detecting moving objects. Optical flow method makes use of optical flows properties that moving objects change over time, and it suits for the static and dynamic background. However, due to its complex computation and the poor anti-noise performance, the special hardware is needed in real time processing [3]. The frame difference, or time difference, extracts the motion regions by the threshold of time difference in adjacent frames pixels. The presence of moving objects determined by calculating the difference between two consecutive images, in the frame subtraction method. Its calculation is simple, insensitive to the change of light, good adaptive performance and easy to implement. For a variety of dynamic environments, it has a strong adaptability, but it is generally difficult to obtain complete outline of moving object, cannot detect the moving object which has a large size and identical inter colour, responsible to appear the empty phenomenon, as a result the detection of moving object is not accurate. Out of these three categories, background subtraction received the most attention due to its computationally affordable implementation and its accurate detection of moving entities. Background subtraction is based on the comparison between input video frame and the background to detect the moving objects, or foreground [4].

The major methods are median filter linear prediction, single Gaussian background model, mixed Gaussian background model, kernel density estimation, etc[5]. These methods are easy and fast. But there are still some problems. The major external condition is the low detection accuracy due to the change of light and the noise. The inherent limitations of the method are hollow space, streak phenomena, stretched moving objects, etc. At present, hundreds of papers about the algorithm of detection and extraction of moving objects are published every year. There is still no general segmentation theory now. Existing segmentation theories are limited for special problems. For practical application, background subtraction is widely used. This project improves the general background subtraction by using dynamic threshold method. Experimental result shows that this algorithm has low complexity and good detection performance under complex background [6][7][8][9][10].

At present methods used in moving object detection are mainly the frame subtraction method, the background subtraction method and the optical flow method. In the frame difference, or Frame Subtraction method detect moving objects by calculating the differences between pixels in consecutive frames of a video sequence, as well as extracts the motion regions by the threshold of time difference in adjacent frames pixels. Although frame Subtraction approaches are adaptive to environments with sudden illumination change, some relevant pixels cannot be extracted; this results in holes inside moving entities [6]. Optical flow method is to calculate the image optical flow field, and do clustering processing according to the optical flow distribution characteristics of image. This method can get the complete movement information and detect the moving object from the background better, however, a large quantity of calculation, sensitivity to noise, poor anti-noise performance, make it not suitable for real-time demanding occasions.

The background subtraction method is to use the difference method of the current image and background image to detect moving objects, with simple algorithm, but very sensitive to the changes in the external environment and has poor anti- interference ability. However, it can provide the most complete object information in the case of the background is known. It received the most attention due to its computationally affordable implementation and its accurate detection of moving entities. In this project, in a single static camera condition, we combine dynamic background modelling with threshold selection method based on the background subtraction, and update current frame on the basis of exact detection of object. This method is effective to improve the effect of moving object detection. Any motion detection system based on background subtraction needs to handle a number of critical situations such as:

1. Noise image, due to a poor quality image source.
2. Gradual variations of the lighting conditions in the scene.
3. Small movements of non-static objects such as tree branches and bushes blowing in the wind.
4. Undeviating variations of the objects in the scene, such as cars that park (or depart after a long period).
5. Sudden changes in the light conditions, (e.g. sudden raining), or the presence of a light switch (the change from daylight to non-natural lights in the evening).
6. Movements of objects in the background that leave parts of it different from the background model;
7. Shadow regions that are projected by foreground objects and are detected as moving objects.
8. Multiple objects moving in the scene both for long and short periods.

The main objective of this paper is to develop an algorithm that can detect human motion at certain distance for object tracking applications. We carry out various tasks such as motion detection, background modelling and subtraction, foreground detection, shadow detection and removal.

II. OVERVIEW

The background subtraction is a widely used approach for detecting moving objects in videos from static cameras. The rationale in the approach is that of detecting the moving objects from the difference between the current frame and a reference frame, often called the "background image", or "background model". **As** a baric, the background image must be a representation of the scene with no moving objects and must be kept regularly updated so as to adapt to the varying luminaries conditions and geometry settings [1]. More complex models have extended the concept of "background subtraction" beyond its literal meaning.

The background subtraction method is the common method of motion detection. It is a technology that uses the difference of the current image and the background image to detect the motion region [4], and it is generally able to provide data included object information. The key of this method lies in the initialization and update of the background image. The effectiveness of both will affect the accuracy of test results. Therefore, this paper uses an effective method to initialize the background, and update the background in real time.

A. Background Image Initialization

There are many traditions to obtain the initial background image. For example, the average pixel brightness of the first few frames as the background or with the first frame as the background directly, or using a background image sequences without the prospect of moving objects to estimate the background model parameters and so on. Among these methods, the time average method is the most commonly used method of the establishment of an initial background However, this method cannot deal with the background image (especially the region of frequent movement) which has the shadow problems. While the method of taking the median from continuous multi-frame can resolve shadow problem simply and effectively. So the median method is selected in this paper to initialize the background. Expression is as follows:

$$Binit\ (X,\ y) = median\ fk\ (x,\ y)\ k = 1,2,''..n$$
Where Binit is the initial background, n is the total number of frames selected.

B. Background Modernizes

For the background model can better adapt to light changes, the background needs to be updated in real time, so as to accurately extract the moving object. In this paper, the update algorithm is as follows:

In detection of the moving object, the pixels judged as belonging to the moving object maintain the original background gray values, not be updated. For the pixels which are judged to be the background, we update the background model according to following rules:

$$Bk+1(x,y)=\beta Bk(x,y)+(1-\beta)Fk(x,y)$$

Where β belongs to **(0,1)** is update coefficient, in this paper $f3 = 0.004$. $Fk(x,y)$ is the pixel gray value in the current frame. $Bk(x,y)$ and $Bk+1(x,y)$ 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 in the long period of time. Using this method can effectively 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 by the update of pixel gray value of the background, the impact brought by light, weather and other changes in the external environment can be effectively adapted.

III. PROPOSED FRAMEWORK

A. Moving Object Mining

Background subtraction is a popular technique to segment out the interested objects in a frame. This technique involves subtracting an image that contains the object, with the previous background image that has no foreground objects of interest. The area of the image plane where there is a significant difference within these images indicates the pixel location of the moving objects [3]. These objects, which are represented by groups of pixel, are then separated from the background image by using threshold technique.

After the background image $B(x, y)$ is obtained, subtract the background image $B(x,y)$ from the current frame $Fk (x, y)$. If the pixel difference is greater than the set 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. Its expression is as follows:

$$D_k(x,y) = \begin{cases} 1 & |Fk\ (x,y) - Bk-1(x,y)| > T \\ 0 & other \end{cases}$$

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 in this paper we proposed the dynamic threshold method. By using this method we dynamically changes the threshold value according to the lighting changes of the two images obtained. On this basis, add a dynamic threshold $DeltaT$ to the above algorithm. Its mathematical expression is as follows:

$$\Delta T = \lambda \cdot \frac{1}{M \times N} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} \left| F(i,j) - B(i,j) \right|$$

Then

$$D_x(x,y) = \begin{cases} 1 & |Fk\ (x,y) - Bk-1(x,y)| > T + \Delta T \\ 0 & Others \end{cases}$$

Where A is the inhibitory coefficient, set it to a value according to the requirements of practical applications, and the reference values is 2. $M \times N$ is the size of each image to deal with. $M \times N$ numerical results indicate the number of pixels in detection region. This method can effectively suppress the impact of light changes.

B. Reprocessing

As the difficulty of the background, the discrepancy image obtained contains the motion region as well as large number of noise. Therefore, noise needs to be removed. In this paper we adopts median filter with the 3 X 3 window for filtering some noise.

After the median filter, motion region just not includes human being, but also it may include moving cars, flying. birds, flowing clouds and swaying trees and other non body parts. Morphological methods are used for further processing. Corrosion operation is taken to effectively filter out non-human activity areas and by using the expansion operation they can filter out most of the non-body motion regions while preserving the shape of human motion without injury. After expansion and corrosion operations, some isolated spots of the image and some interference of small pieces are eliminated, and we get more accurate human motion region.

C. Extraction Of Moving Human Body

After median filtering and morphological operations, some accurate edge regions will be got, but the region belongs to the moving human body could not be determined. Through observation, we can find out that when moving object appears, shadow will appear in some regions of the scene. The presence of shadow will affect the accurate extraction of the moving object. By analysing the characteristics of motion detection, we combine the projection operator with the previous methods [8].

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 eliminate the impact of the shadow to a certain degree. Then we analyse 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 to determine the number and width of the body in the motion region, we will get the moving human body with precise edge. This paper assumes that people in the scene are all in upright-walking state.

IV. **RESULTS**

- Matlab simulation results for save video

Fig.1 Original Colour Video   Fig.2   Gray Scale Image   Fig.3   Background Image
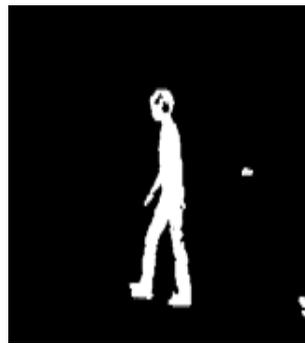

Fig.4   Output Image=Gray Scale Image -Background Image

V. **CONCLUSION**

In this paper, our proposed method of moving human detection will help to find the moving object perfectly in the approved manner. It can be achieved with high accuracy and reliability. To minimize or avoid the problems approaching in moving object detection, we used threshold method to detect moving object, background initialization and update the current image in real time. At last, shadow effect and noise removed by using median filter method. This method has also a very good effect on the elimination of noise and shadow, and be able to extract the complete and accurate picture of moving human body. The simulation results by MATLAB show that the background subtraction is useful in both detecting and tracking moving objects, and the background subtraction algorithm runs more quickly.

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