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Efficient Background Subtraction and Shadow Removal Technique for Multiple Human object Tracking

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Abstract: This paper proposed a method to detect moving object based on background subtraction and shadow removal. First, we established a reliable background updating model based on statistics and we used a dynamic optimization threshold method to get a more clear moving object and finally we performed morphological filtering to eliminate the noise and our background disturbance problem is solved. At last, shape analysis method is combined with contour projection analysis to remove the shadow from a specific image, and moving human body is accurately and reliably detected. The occlusion is the most common events in object tracking and object centroid of each object is used for detecting the occlusion and identifying each object separately. The experimental result shows that the proposed method runs quickly, accurately and fits for the real time application. Video sequences have been captured in the laboratory and tested with the proposed algorithm. The algorithm works efficiently.

Keyword: Object tracking, background subtraction, shadow removal and occlusion detection.

I. INTRODUCTION

A shadow is an area where direct light from a light source cannot reach due to obstruction by an object. Shadow detection and removal is an important task in image processing when dealing with the outdoor images. Shadow occurs when objects stop up light from light source. Shadow often degrades the visual quality of images. Shadow an object with two type of shadow self-shadow and cast shadow. Self-shadow is objects itself and another is cast-shadow. Self-shadow usually have a higher brightness than cast shadows.

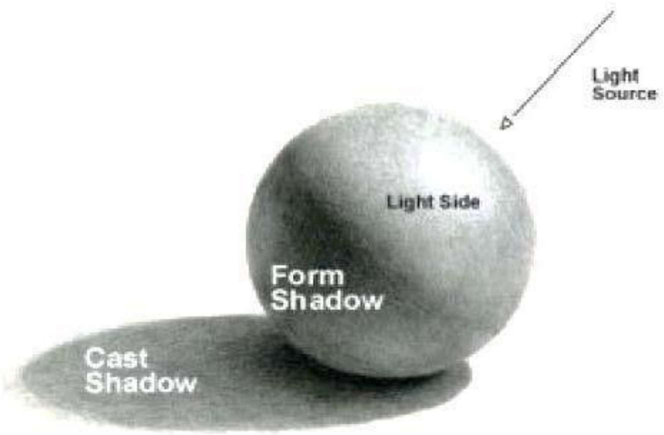


Fig. Shadow is divided as cast-shadow and self-shadow

Human body motion analysis is one of the most important technology which modern bio-mechanics combines with computer vision and has been mostly used in human-computer interaction, virtual reality and other various fields [1]. The most important part of human body motion analysis is the moving human body detection. Our purpose is to detect the moving human body from the background image in video sequences and then perform the target classification, tracking the human body and behavior understanding. Presently, the different methods used in moving object detection are frame subtraction, background subtraction and optical flow method [2]. Frame subtraction method [3, 4] is simply the difference between two consecutive images to determine the presence of moving objects. It's very easy to implement and simple to calculate. Only the disadvantage of this method is that it is difficult to obtain complete outline of moving object as a result the detection of moving object is not accurate. The background subtraction method[7] 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[8]. Optical flow method [5,6] is to calculate the image optical flow field and do cluster processing according to the optical flow distribution characteristic of the 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.

Human object tracking can be defined as the process of segmenting an object of interest from a video scene and keeping track of its motion, orientation, occlusion etc. in order to extract useful information. Moving object tracking process follows the segmentation step and is more or less equivalent to the „recognition‟ step in the image processing. Detection of moving objects in video streams is the first relevant step of information extraction in many computer vision applications, including traffic monitoring, automated remote video surveillance, and people tracking.

The object tracking methods may broadly be categorized as template-based, probabilistic and pixel-wise. While the template-based method represents the object in a suitable way for tracking, the probabilistic method uses intelligent searching strategy for tracking the target object. Similarly, the similarity matching techniques are used for tracking the target object in pixel-based methods. However, among all the above said approaches, the template-based approach is found to be suitable for many real-time applications [1, 2]. In this category of tracking methods, similarity of the predefined target is being calculated with the object translation. However, for object transformations such as translation, rotation and scaling this method often fails. This is due to the fact that the procedures of selection of target object as constant size templates. For handling this difficult issue, varying templates are used. The inclusion of background pixels into the template introduces the problem of positioning error and the positioning error continuously getting added while updating the template. In template -based approach category, mean-shift method 3] and Kernel-based tracking method [4] have been proposed, where the color histograms of the target object is constructed Using a Kernel density estimation function. Since, the color Histogram is invariant feature for rotation, scaling and Translation, it is considered as one of the suitable feature for handling the problem of change in the scale, rotation and translation of target object. The object tracking is carried out by comparing the color histogram of the template and the target object. However, mean-shift method is not suitable for -D target object and monochromatic object. In case of monochromatic target object, even small variation in illumination, produces narrow histogram pattern and tracking often fails.

In applications using fixed cameras with respect to the static background (e.g. stationary surveillance cameras), a very common approach is to use background subtraction to obtain an initial estimate of moving objects. Basically, background subtraction consists of comparing each new frame with a representation of the scene background significative differences usually correspond to foreground objects. Ideally, background subtraction should detect real moving objects with high accuracy, limiting false negatives (objects pixels that are not detected) as much as possible; at the same time, it should extract pixels of moving objects with the maximum responsiveness possible, avoiding detection of transient spurious objects, such as cast shadows, static objects, or noise.

In this paper, we present a shadow removal technique which effectively eliminates a human shadow cast from an unknown direction of light source. Our algorithm improves the shadow detection accuracy by imposing the spatial constraint between the foreground subregions of human and shadow. The existence of human shadows is a general problem in tracking and recognizing human activities. Shadows not only distort the color properties of the area being shaded but also complicate the edge structure of the figure as a whole. There are several factors that together determine the appearance of a shadow, for example, the view point of camera, the angle of incidence, the light intensity, and the number of light sources, etc. Further, under the sun, the dominant orientation of a human shadow changes as a function of time. Therefore, a human tracker becomes more prone to miss the target, and the motion pattern of a single action varies considerably.

II. Background Subtraction

Background subtraction is the common method to segment out the interested objects in a frame. It is one of the most useful method which uses the difference of the current image and the background image to detect the motion region [9], and it is generally able to data included object information. The key of this method lies in the initialization and update of the background image.

1. Initialization of Background Image

There are many ways to obtain the initial background image such as; with the first frame as the background directly, or the average pixel brightness of the first few frames as the background 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 [l0].

However, this method cannot deal with the background image which has the shadow problems. While the method of taking the median from continuous multi-frame can resolve this problem simply and effectively. So the median method is selected in this paper to initialize the background.

Expression is as follows:

$$Bini(a,b) = median\ fm(a,b) \text{ where } m=1,2,3,....n$$

Where; Bini is the initial background **n** is the total number of frames selected.

2. Background Update

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:

$$Bm+1(a,b) = beta\ Bm(a,b)+(1-beta)Fm(a,b)$$

Where beta belongs to (0,1) is update coefficient , in this paper beta=0.004, Fm(a,b) is the pixel grey value in the current frame. Bm(a,b) and Bm+1(a,b) are respectively the background value of the current frame and 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. Object tracking

Object tracking can be defined as the process of segmenting an object of interest from a video images and keeping track of its motion, orientation, occlusion etc. in order to extract useful information.

Steps in Human object tracking:

1. Segmentation

   Segmentation divides an image into constituent regions or objects that have similar features according to a set of predefined criteria. Segmentation process identifies the some specific components of the image.

2. Foreground extraction

   Foreground extraction is the process which identifies the location of an object in the image. This is the process of separating the background and foreground of the image.

3. Background extraction

   The motion detection system is the part of background subtraction that effectively extracts the shape of moving objects and subtracts average background from image. Once we know the background, extracting the foreground is matter of simple image subtraction.

4. Camera modeling

   Camera is used to capture images. Camera modeling is an important aspect of each and every object tracking algorithm. The entire object tracking models which are already exists use a preset camera model. In words camera model is directly derived from the domain knowledge are required to adjust all the inputs. It needs the algorithm to model motion of all the cameras as well as to integrate the result from all the cameras.

5. Feature extraction and tracking

   Feature extraction methods of constructing combination of the variable to get data with sufficient accuracy. This extracts meaningful information. This is involves simplifying the amount of resources required to described a large set of data accurately. This is an area of image processing that uses algorithms to detect and isolate various desired portions of a digitized image. A feature is a significant piece of information extracted from an image which provides more detailed understanding of the image.

Human motion analysis and detection are the foremost task in computer vision based problems. Human detection aims at segmenting regions corresponding to people from the entire image. It is a significant issue in human motion analysis system since the subsequent processes such as tracking and action recognition follows the motion detection. The motion detection and foreground object extraction algorithm consists of several sequential processes.

The process algorithm is described in a flow chart and shown in following Fig.

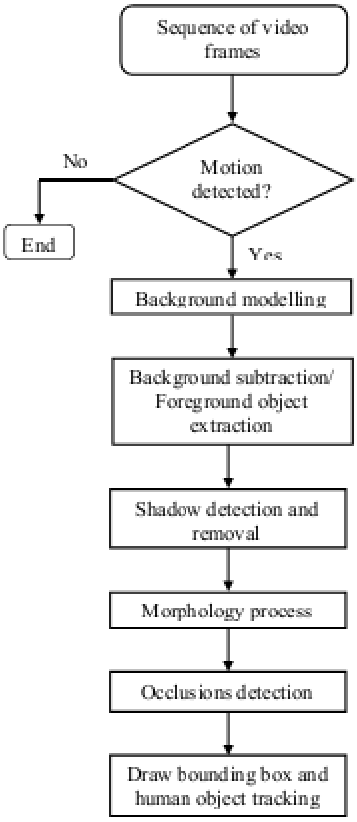


Fig: Flow Chart for Human Object Tracking

The flow chart of moving human body extraction is shown in following figure**:** Human body detection is to identify the corresponding part of human from the moving region. But the extracted moving region may correspond to different moving objects, such as pedestrians, vehicles and other such birds, floating clouds, the, swaying tree and other moving objects. Hence we use the shape features of motion regions to further determine whether the moving object is a human being. Judging criteria are as follows:

(1) The object area is larger than the set threshold

(2) The aspect ratio of the object region should conform to the set ratio.

If these two conditions are met, the moving object is the moving human body, or is not a human body

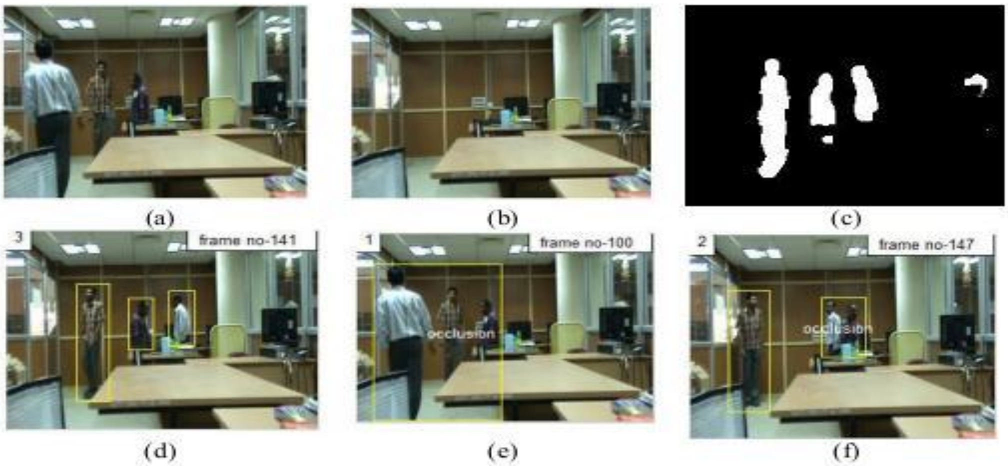


Fig. Object tracking process (a) Video Sequences, (b) Background Model, (c) Background Subtraction, (d) Multiple Object Tracking with Bounding Box, (e) & (f) Occlusion Detection

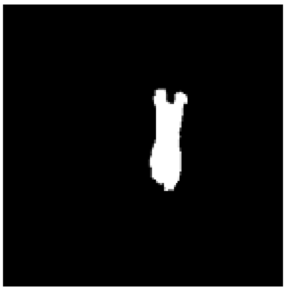
IV. OCCLUSION DETECTION

While two moving objects coming closer to each other, the background subtracted frame shows it as a single object. This situation is called as occlusion and will create problem while tracking two objects. In this approach, an algorithm is proposed for detecting the occlusion. This approach will inform the frame number where the occlusion has taken place. In the number of object in the frame is increased suddenly shows the entry of new objects into the frame or separation of occluded objects. Consequently if there is a sudden reduction of number of objects present in the frame indicates the process of occlusion of two or more objects or the exit of the objects from the frame to the outside area.

This situation is experimented and is depicted in following Fig. (a)-(d).


(a)


(b)


(b)

(d)

Fig. Occlusion detection and background subtraction (a) Video Frame, (b) Background Subtraction, (c) BW Image Showing Objects and (d) Occlusion Detection

V. EXPERIMENTENTAL RESULTS

The experimental results are presented to show that the proposed methods can achieve promising performance in background subtraction and foreground object extraction. This system detects and tracks the moving objects exactly. In this approach, the background scene is modeled using a set of background image frames, which basically consists of 5-30 consecutive frames. The object pixels are segmented out from its background followed by post- morphological process such as dilation and erosion to eliminate noisy pixels thus producing better results.

1. Comparative results

Kalman filter approach [26], algorithm is used for detecting and tracking the human objects in the video sequences. This algorithm is compared with the proposed approach for performance evaluation. Fig. 6(a) shows the tracking strategy of Kalman filter algorithm and (b) shows the tracking strategy of the proposed technique. While comparing the performance of Kalman filters and proposed approach, the following issues are observed. (i) In most of the frames, the moving human objects are not tracked due to the static behavior of objects in the consecutive frames by Kalman filter algorithm. In the proposed approach, the background is frames. Thus, the background model helps the proposed approach to track the static human objects without failure. (ii) The computation time for tracking the human objects in the video sequences using proposed approach is very low compared to Kalman filter algorithm.

(a) kalman filter's results

(b) Proposed background subtraction & shadow Removal

VI. CONCLUSION

In this paper, an approach capable of detecting motion and extracting object information which involves human as object has been described. The algorithm involves modeling of the desired background as a reference model for later used in background subtraction to produce foreground pixels which is the deviation of the current frame from the reference frame. The deviation which represents the moving object within the analyzed frame is further processed to localize and extracts the information. The occlusion has also been dealt effectively.

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