Human Object Tracking using Background Subtraction and Shadow Removal Technique

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Abstract— **The main objective of this paper is to develop multiple human object tracking approach based on motion estimation and detection, background subtraction, shadow removal and occlusion detection. A reference frame is initially used and considered as background information. While a new object enters into the frame, the foreground information and background information are identified using the reference frame as background model. Most of the times, the shadow of the background information is merged with the foreground object and makes the tracking process a complex one. The algorithm involves modelling of the desired background as a reference model for later used in background subtraction to produce foreground pixel which is deviation of the current frame from the reference frame. In the approach, morphological operations will be used for identifying and removed the shadow. The occlusion is one of the most common events in object tracking and object centroid of each object is used for detecting the occlusion and identifying each object separately. Video sequences will be captured and will be detected with the proposed algorithm.**

Keywords— Human motion detection, object tracking, Background detection, subtraction and shadow removal.

I. INTRODUCTION

Shadow is a common problem that one could meet in motion estimation of daytime traffic scenes. A shadow is an area where direct light from a light source cannot reach due to obstruction by an object. A shadow occurs when an object partially or totally occludes direct light from a source of illumination. There are two types of Shadow, self Shadow & cast shadow. Self shadow occurs in the portion of a object which is not illuminated by direct light.

Cast Shadow is the area projected by the object in the direction of direct light. Self Shadow is again divided into two parts: Shading & Interreflection. & Cast Shadow is also again divided into two parts: Umbra & Penumbra, Umbra, is the darkest part of the shadow.

In umbra, the light source is completely occluded, Penumbra, is the region in which only a portion of the light source is obscured by the occluding body. We needed shadow removal because Shadows cause tracking, segmentation or recognition algorithms to fail. Shadows have proven to be a large source of error in the detection and classification of vehicles. Real images with shadows can‘t be used for image synthesis. Shadows can cause object merging, object shape distortion etc., causing error in object tracking and classification. Many shadow detection or removal is based on priori information, such as the geometry of the scene or the moving objects and the location of the light source while others are based on shadow attributes. There are three main shadow attributes, firstly, shadows or moving shadows are attached to their respective obstruction object for most of the time, secondly, transparency which is that shadow always makes the region it covers darker and lastly, homogeneity which is the ratio between pixels when illuminated and the same pixels under shadows can be roughly linear.

II. LITERATURE REVIEW

An image division technique is used to divide the image (between background and foreground). Image division is used because it highlights the homogeneity property or attributes of shadow. After the image division process, adaptive thresholding process is used to remove the umbra region and projection histogram analysis is applied to the resultant image to remove the penumbra region. The global thresholding process is applied to the resultant image (after image division) in order to get the shadow's blob [2] [3].

The shadow detection method is applied to gray level images taken by a stationary camera. The Canny edge detector is used to both the foreground and background figures. After that, image subtraction is performed on the foreground edges and background edges to extract the object's edges. Object recovery process is applied to the object's edges to recover object shapes on the basis of the information in the object's edges and attributes of shadow. There are three rules or attributes of shadow as defined by authors. Firstly, bright foreground pixels is preserved because they are impossible to belong to shadows. Secondly, foreground pixels with attributes different from the attributes of shadow are preserved

and lastly, foreground pixels nearby object edges are preserved [5].

The approach is applied for human or pedestrian and it is based on priori information which is object moment and object orientation. In order to precisely remove the unwanted shadows, presents a histogram projection method to separate each pedestrian from moving region first. Then, a coarse-to-fine approach is applied for detecting the boundaries between the pedestrian and its shadow. At the coarse stage, a moment-based method is applied to estimate the orientation of the detected pedestrian [6]. According to the orientation and silhouette features of the detected regions, a rough approximation of the exact shadow area can be detected. At the fine stage, the rough approximation of the shadow region is further refined through Gaussian shadow modelling. The major difficulty in shadow modelling is the choice of the proper model, which can reflect various appearances of shadows at different orientation and lighting. The algorithm is also based on priori information plus a little bit of shadow attributes. The algorithm tries to locate object-shadow boundary in order to detect the shadow.

This was done by creating one or more straight lines to approximate the boundary between vehicles and their associated shadows [7]. These lines are located in the image by exploiting both local information e.g. statistics in intensity differences and global information e.g. principal edge directions. This method does not assume a particular lighting condition, and required no human interaction or parameter training. Experiments on practical real-world traffic video sequences demonstrate that this method is simple, robust and efficient under traffic scenes with different lighting condition..

III. MOTIVATION

Many techniques which are based on homogeneity property of shadows assume that ratio between pixels when illuminated and that are when subjected to shadow is constant. But, the ground truth data show that the ratio is highly dependent on illumination in the scene and hence shadow detection will not be effective in case if the ratio is assumed to be constant. In other words, the ratio is always changing due to different illumination for different scenes. That is why; an adaptive thresholding technique can be used to improve or to solve the problem. Most of the shadow detection that are developed based on homogeneity property or image division technique just assume the ratio is always constant and use fix threshold value for the thresholding process (global thresholding).

In addition, most of the shadow detection that use image division technique always use an additional technique after the image division process because the image division process is used to highlight the homogeneity property of shadow especially the umbra region but not penumbra. That is why; so many additional processes have proposed in order to remove the penumbra region such as multi-gradient analysis and projection histogram analysis

IV. APPLICATIONS

A very fundamental and critical task in computer vision is the detection and tracking of moving objects in video sequences. Possible applications are as follows Visual surveillance: A human action recognition system process image sequences captured by video cameras monitoring sensitive areas such as bank, departmental stores, parking lots and country border to determine whether one or more humans engaged are suspicious or under criminal activity. Content based video retrieval: A human behavior understanding system scan an input video, and an action or event specified in high-level language as output. This application will be very much useful for sportscasters to retrieve quickly important events in particular games.

Precise analysis of athletic performance: Video analysis of athlete action is becoming an important tool for sports training, since it has no intervention to the athletic. In all these applications fixed cameras are used with respect to static background (e.g. stationary surveillance camera) and a common approach of background subtraction is used to obtain an initial estimate of moving objects.

First perform background modelling to yield reference model. This reference model is used in background subtraction in which each video sequence is compared against the reference model to determine possible variation. The variations between current video frames to that of the reference frame in terms of pixels signify existence of moving objects.

The variation which also represents the foreground pixels are further processed for object localization and tracking. Ideally, background subtraction should detect real moving objects with high accuracy and limiting false negatives (not detected) as much as possible. At the same time, it should extract pixels of moving objects with maximum possible pixels, avoiding shadows, static objects and noise.

V. OBJECTIVE & SCOPE

The main objective of this project is to develop an algorithm that can remove object's shadow .Various tasks are carried out such as motion detection, background modelling and subtraction, foreground detection, shadow detection and removal, morphological operations and identifying occlusion. Very few works have done for shadow detection and removal in case of images up to this time. There are five approaches based on shadow properties to detect and removal of shadow:

A] Model Based Technique.

In Model based technique, the geometry and illumination of the scene are assumed to be known. This includes the camera

localization, the light source direction, and the geometry of observed objects, from which a priori knowledge of shadow areas is derived. In most applications the geometry of scene and/or light sources are unknown This technique is oldest in all techniques.

B] Image Based Technique.

Image based technique makes use of certain image shadow properties such as colour (or intensity), shadow structure (umbra and penumbra), boundaries, etc., without any assumption about the scene structure.

If any of that information is available, it can be used to improve the detection process performance. Shadow do not change the surface texture, surface marking tend to continue across a shadow boundary under general viewing conditions. [10] In some color components (or combination of them) no change is observed whether the region is shadowed or not, this is invariant to shadows [11].

C] Colour/Spectrum Based Technique.

The Colour based technique attempts to describe the colour change of shaded pixel and find the color feature that is illumination invariant. The pixel's intensity change equally in RGB colour components and a diagonal model proposed to describe the colour distortion of shadow in RGB space [12].It is found that shadows change the hue component slightly and decrease the saturation component significantly. The shadow pixels cluster in a small region that has distinct distribution compared with foreground pixels. The shadows are then discriminated from foreground objects by using empirical thresholds on HSV colour space. [13]

D] Texture Based Technique.

The principle behind the textural model is that the texture of foreground objects is different from that of the background, while the texture of the shaded area remains the same as that of the background. The several techniques have been developed by using this technique. The technique is a good approach and it is based on the observation that shadow regions present same textural characteristics in each frame of the gray-level video sequence and in the corresponding adaptive background model. [8,9]The technique proposed includes the generation of initial change detection masks and canny edge maps. [14]

E] Geometry Based Technique.

Geometric Model based technique makes use of the camera location, the ground surface, and the object geometry, etc., to detect the moving cast shadow, The Gaussian shadow model was proposed to detect the shadow of pedestrian. The model is parameterized with several features including orientation, mean intensity, and centre position of a shadow region with the orientation and centroid position being estimated from the properties of object moments. [15] This technique has some similarity with the model based technique.

VI. PROPOSED SYSTEM DESIGNING & PLANNING

THE ALGORITHM

The flowchart in figure 1 shows the main flow chart of algorithm of the project that has been proposed. It has been assumed that the input (object's blob and background's blob) is obtained from background subtraction. All process in figure 1 is explained in the following sections.

Image Division

In this process, the object's blob, ob(x, y), {x, y € Z^2} is divided with the background's blob, bk(x, y), {x,y € Z^2} It has been said before that the purpose of image division is to highlight the homogeneity property of shadows. Resultant image after the division process is multiplied with a constant for the purpose of increasing the signal of the resultant image. In this case, the constant value is 100 (Eq.]). The result of this process is define as Img_ Div(x, y).

$$Img\_Div(x,y) = \frac{ob(x,y)}{bk(x,y)} \times 100, \forall x \in X, \forall y \in Y \quad (1)$$

Thresholding

The purpose of thresholding is to decide the shadow's blob in the resultant image after the image division process (Img-Div). Most of the existing approaches mark pixels lying between a certain ranges of value in the division image as belonging to a shadow. However, the range is highly dependent on the illumination in the scene. In addition, different scenes also produce different level at illumination. An adaptive Threshold had proposed in order to solve this type of problem. However, this technique has been tested with a few video samples and it seems that this technique does not work effectively compared to a fixed threshold. It is because the range of adaptive threshold depends on the average value of the division image and this will cause that the threshold value (range) that belongs to the shadow change randomly. Because of this problem, in this proposed technique, the range has been set according to the scene (Eq.2) and this is done by studying the histogram of the division image over a few samples.

$$Img\_Th = \begin{cases} 1, t\_\min \le Img\_Div \le t\_\max \\ 0, otherwise \end{cases}, \forall (x, y)$$

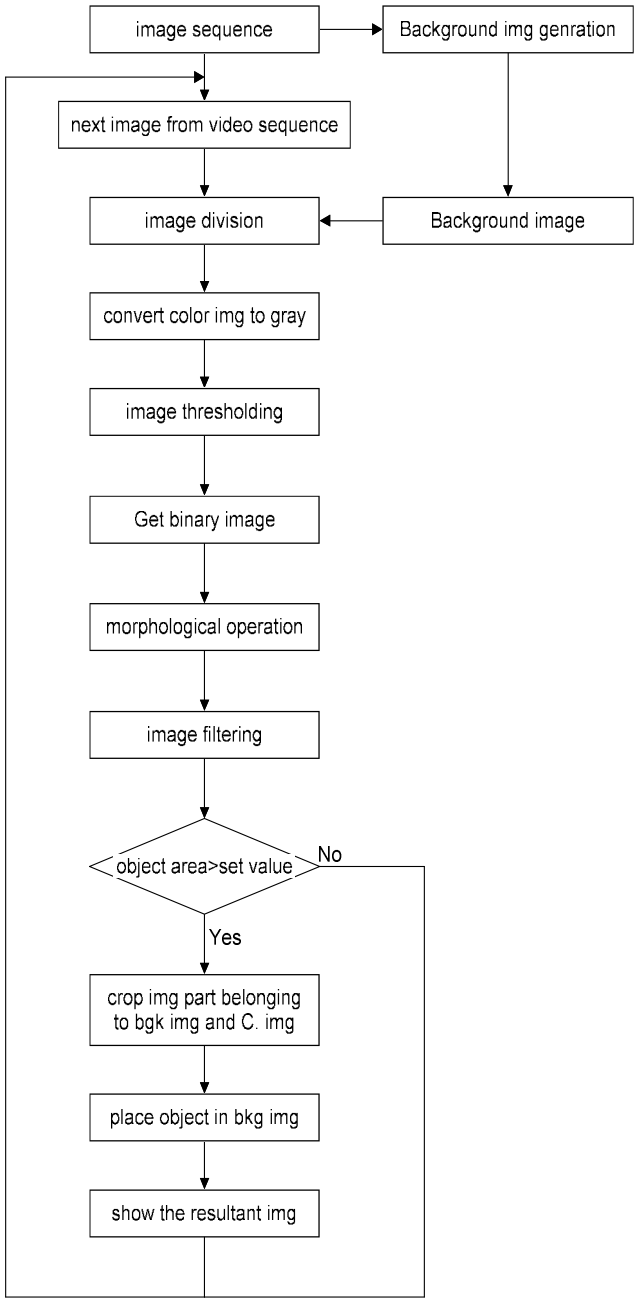

Fig 1: Algorithm of proposed shadow removal technique

Filtering

The purpose of filtering is to enhance the resultant image after the thresholding process (Img_Th) and to find the biggest blob which is predicted as the shadow's blob or shadow region. Filtering process include filling, erosion and dilation to enhance the image and labelling to predict the shadow. It is assumed that the biggest blob after the labelling process or connected component process as a shadow region.

Fig 2: Shadow removal process

Conclusion

This paper represents the methodology to remove shadow for different background. It is an approach capable of detecting motion and extracting object information which involves human as object will be 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. This shows that it is possible to remove shadow from image without losing a large amount of pertinent data.

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