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Moving Object Detection in Traffic Video using Optical Flow

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***ABSTRACT* -** With the abrupt increase of motor vehicles, the advanced Intelligent Traffic Monitoring System is important in today's world. Automatic video segmentation plays an important role in the ITMS. Many algorithms have been proposed on automatic video segmentation. However, due to the large computation, many of them can-not be used for the real-time applications. Segmentation of moving objects in a scene is often desired in many applications for monitoring motion. In the project, we look at traffic videos. The approach used for object-oriented video segmentation is based on motion coherence.

KEYWORDS- Lucas Kanade method. Motion vector, Optical flow estimation, SAD Video segmentation,

I. INTRODUCTION

Segmentation is the process of partitioning a digital image into multiple segments. The aim of segmentation is to simplify and change the representation of an image .The image obtained from this type is more meaningful and easy to analyze. Image segmentation is used to locate objects and boundaries in images.

For the traffic video image analysis, segmentation is the key from which the movement, state of vehicles can be studied to get traffic flow parameters. Traffic video analysis can provide a wide range of useful information such as vehicle motion, traffic flow, to traffic planners.

In this method object detection is an important task. Object detection is some complex process as the camera motion and object motion are mixed. For this, motion vectors, which represent flow of a moving object, are obtained using Lucas - kanade optical flow algorithm for moving object detection with complex background. Optical flow technique yields a two-dimensional motion vector (MV). MV indicates the velocities as well as the directions of each pixel of two consecutive frames in a time sequence. Suppose two gray scale frames I1 and I2 are taken at time t and t+δt, respectively. The aim of this method is to compute motion vector to detect motion. In order to design this motion vector, find out the position of a point in frame I2 such that its intensity matches with the intensity of I1 at particular point position (x, y). As shown in fig. 1.1, considering the point (x+δx, y+δy) in I2 which is having similar intensity as I1(x, y), the equation can be expressed as

$$I(x, y, t) = I(x+\delta x, y+\delta y, t+\delta t) \qquad (1)$$

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Using Taylor series expansion method, (1) is simplified and ignoring higher degree terms, the following equation can be determined.

$$I_x v_x + I_y v_y = - I_t \qquad (2)$$

Where, $(v_x, v_y) = (\delta x/\delta t, \delta y/\delta t)$.

This represents motion vectors or optical flow vectors and represent gradient of intensity values at coordinate (x, y) in the frames at time t.

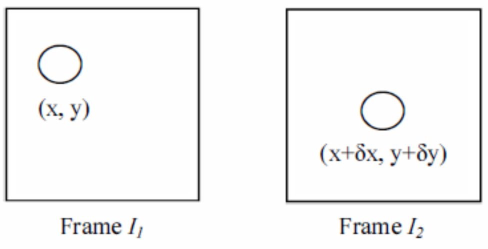

Fig. 1. Example of Motion Flow.

Optical flow is motion pattern of object caused by relative motion between scene and eye. Optical flow calculates the motion of objects such as edges, corners, surfaces, and other complicated color patterns between consecutive frames in the video. It is widely used in motion-based image processing.

II. METHOD OVERVIEW

In proposed method segmentation is done using motion based segmentation. Motion segmentation is an important in many areas and video processing task. The idea of motion-based segmentation is to extract the moving objects by identifying regions of coherent motion. One approach for this was SAD (Sum Absolute Difference) method. Operation as follows: SAD operation is performed on current frame and reference frame .Every frame is divided into the blocks of equal size. By subtracting smallest value from the largest, motion vector is estimated. This vector contains the relative position of the block. But this method is less efficient method as bandwidth required to feed unit is rather high. Also computation is intensive and movement s in video references are usually small hence this approach is limited to a search area. The approach for motion based segmentation consists of estimating optical flow for every pixel in the image. Optical flows are vectors that represent the motion of an object pattern in a video stream. For this Lucas - Kanade method is used to find the optical flow by pyramidal representation. Pyramid creates the level in image. The number of levels used in the pyramid determines the largest motion that we can resolve accurately by solving the optical flow estimation. Here we will use a 3-level pyramid. LK is accurate and cost-efficient algorithm for real-time applications and implementations. To detect the object, simple method is background subtraction. It utilizes the subtraction of the background from the frames. Hence only objects are detected. Lucas - Kanade method uses the fact that the displacement of two nearby instants (frames) is small and approximately constant within the point under

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examination. Consider the 2 x 2 window and applying the 2D motion constraint equation on that window, the following equation can be derived

$$\begin{aligned} I_{x1}v_x + I_{y1}v_y &= -I_{t1} \\ I_{x2}v_x + I_{y2}v_y &= -I_{t2} \\ I_{x3}v_x + I_{y3}v_y &= -I_{t3} \\ I_{x4}v_x + I_{y4}v_y &= -I_{t4} \end{aligned} \quad (3)$$

I_{xi} , I_{yi} and I_{ti} are the partial derivatives of the image with respect to position x_i , y_i and time t_i from (1) and least square fit, they found following solution.

$$\vec{v} = (A^T A)^{-1} A^T f_t \quad (4)$$

Where

$$A = \begin{bmatrix} I_{x1} & I_{y1} \\ I_{x2} & I_{y2} \\ I_{x3} & I_{y3} \\ I_{x4} & I_{y4} \end{bmatrix}; \ \vec{v} = \begin{bmatrix} v_x \\ v_y \end{bmatrix}; \ f_t = \begin{bmatrix} -I_{t1} \\ -I_{t2} \\ -I_{t3} \\ -I_{t4} \end{bmatrix} \quad (4)$$

Hence optical flow velocity can be computed from (4). Lucas-Kanade optical flow vector depends only on the partial derivative of three dimensions x, y and t. Lucas-Kanade method is an accurate and efficient for calculating the motion vector for object detection. It is robust in presence of noise.

III. ALGORITHM FOR OBJECT DECTION

The proposed method in this section is Lucas Kanade and our aim is to detect the moving object in video. After the acquisition and application of all preliminary steps, our next task is to apply bilateral filter as a pre-processing step to smooth the image without blurring, as shown in fig. 3. Bilateral filter is used on normalized gray scale images and it is edge- preserving filter. After pre-processing step, optical flow is computed to get optical flow vectors.

As motion vectors are obtained for each pixel, a predefined threshold is applied to convert vectors into the binary image. At the end of this step, we will have a binary image which represents probability of a pixel as part of being an object. Morphological operations are applied on binary image as a post processing step to reduce the rate of false detection.

A. Pre- processing step: Bilateral Filtering

A bilateral filter, which is used as a pre-processing step, calculates the weighted mean of the pixels within a neighborhood with weights that are found using both the intensity and spatial difference between the central

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pixel and its surrounding pixels. Suppose I(x) and I(y) is the intensity value of pixel x and y respectively where x is a pixel in the image and y is a pixel in the neighborhood of x. The bilateral filtered intensity value of x is

(5)

where, f_s and f_R are the spatial and range filter kernel, respectively. f_s and f_R are the Gaussian filter Bilateral filter is used for smoothing purpose with preserving the edges in image and remove high-frequency components of an image.

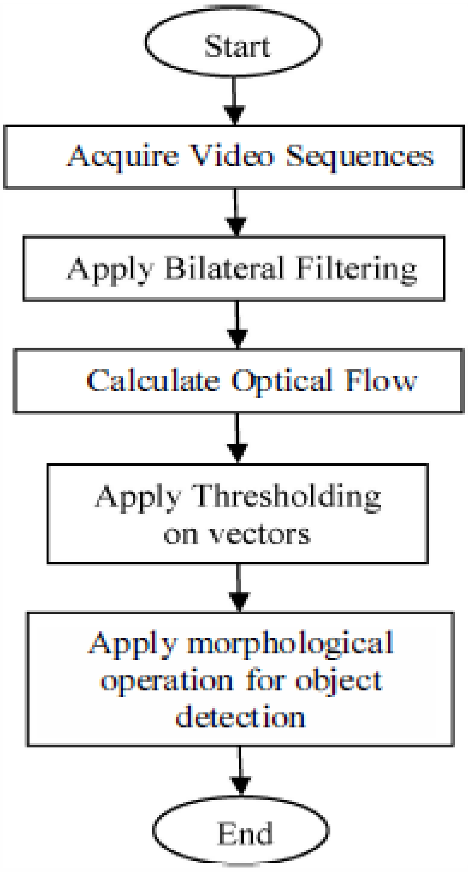

Fig. 2 Algorithm for object detection

B. Optical flow calculation

Lucas - Kanade method is used to find the optical flow by pyramidal representation. Pyramid creates the level in image. Level zero is the original image. The image height and width are same as the original image at level zero. Level 1 is having image with half height and width then the original image. In general, level n has an image with height and width is 2^n times lower than original image

Start with the level l, Find the partial derivatives of intensityI_x, I_y andI_t, and update the motion vector V_x and V_y using Lucas-Kanade method optical flow. If level is less than total number of pyramid, do all the process again. If level is greater than total levels then stop the process.To decide whether a pixel is a part of an object or a background, it is necessary to decide a threshold. Motions vectors (Vx, Vy), obtained from Lucas - Kanade method, and are passed through thresholding process. To find out the threshold, we have used below equation.

Th1= m-sd

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Th2= m+sd (4)

Where m(x) and m(y) are mean value and sd(x) and sd (y) are standard deviation of motion vector Vx and Vy, respectively. If Th1 < MY < Th2 is satisfied then it suggests that it is not the part of an object. Considering object size smaller than background comparably, mean of motion vectors will be biased towards background vectors. If standard deviation at any pixel is high, it is an outlier and may be a part of moving object. Morphological operations like dilation, erosion etc. are used as a post-processing task and moving object are detected

IV. RESULT

Fig.3 Estimated optical color flow

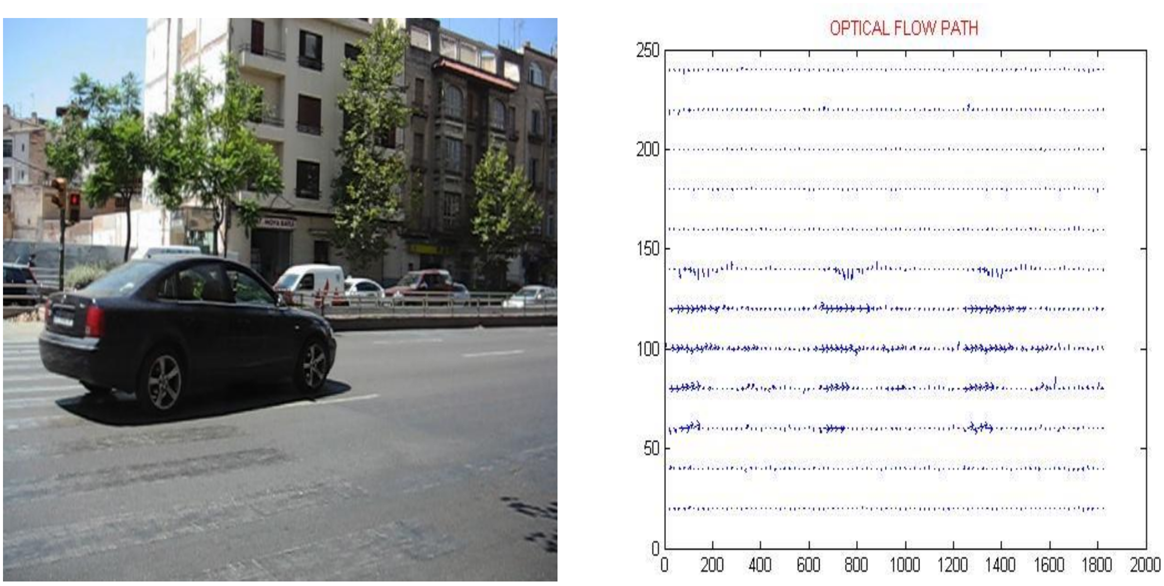

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Fig. 5 Estimated optical flow path

V. CONCLUSION

We have presented method for motion estimation for vehicle detection or tracking. The segmentation method partitions video into homogeneous segments. These segments are considered as building blocks for the motion estimation techniques, which aim to obtain semantic objects by involving high-level knowledge. The method is useful in video surveillance, traffic monitoring object detection object tracking image dominant plane extraction movement detection. Optical flow is not only the study of the determination of the optical flow field itself, but also of its use in estimating the three-dimensional nature and structure of the scene, as well as the 3D motion of objects and the observer relative to the scene.

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