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Simulink Model For Object Tracking using Optical Flow

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Abstract: ***Object tracking and detection is first step in applications such as video surveillance. The main aim of object tracking has been developed to estimate location, velocity and distance parameters of moving objects with the help of static camera. Object tracking system require accurate segmentation of objects from the background for effective tracking. Motion segmentation or optical flow can be used to segment incoming images. Optical flow allows multiple moving targets to be separated based on their individual velocities ,optical flow techniques are prone to errors caused by changing lightning and occlusions, both common in surveillance environment. In this paper we propose a combined motion segmentation/optical flow algorithm for used in object tracking. Optical flow is calculated at pixel resolution and tracking of flow vectors is employed to improve performance and detect discontinuities, which can indicate the location of overlaps between objects.***

Keywords: Objcet tracking,Optical Flow,Motion Detection

1. Introduction

In present age security and safety are one of the major concern of any organization. Thus there is a need for the surveillance system which are both cost and application efficient. The objective of object tracking is to associate target objects in consecutive video frames. The association can be especially difficult when target is moving fast relative to the frame rate. Another situation that increases the complexity when tracked object changes orientation over time. To perform object tracking an algorithm analyzes the sequential video frames and outputs the movement of target between frames. Tracking and surveillance applications require the segmentation of objects from the scene to enable detection and tracking. This can be achieved by using techniques such as motion detection, or optical flow.

A problem with using optical flow for object tracking is it is difficult to initially detect the objects, particularly given that in surveillance environments optical flow algorithms often detect erroneous motion in background regions due to subtle changes in lighting or camera noise. Probabilistic tracking techniques such as particle filtering or the mean shift algorithm work well for tracking as they can overcome noise and erroneous flow errors, however these require an initial detection. Object tracking systems that use motion detection are able to more easily detect objects using the binary image that results from motion detection. However while optical flow can be used to segment overlapping objects using velocity, motion detection cannot. Ideally, motion detection could be used to perform initial object detection and optical flow used there after once the targets velocity is known, but running both algorithms is computationally prohibitive. The objective of this project is to identify and track a moving object within a video sequence. The tracking of the object is based on optical flows among video frames in contrast to image background-based detection. The proposed optical flow method is straightforward and easier to implement and we assert has better performance. The idea of this project is derived from the tracking section of the demos listed in MATLAB computer vision toolbox website.

2. Design and Implementation

In this Simulink model, there are couple of major parameters that we need to adjust depending what the tracking object is. The first parameter is the gain after the mean blocks in the velocity threshold subsystem. If too much background noise besides the moving objects is included in the output intensity matrix, the gain need to be adjust to filter out background in the image. The second parameter is the constant that is used for comparison with the boundary box. Any boundary boxes with area below this constant is filter out. One of the disadvantages of optical flow based tracking is that a moving object may have many small boundary boxes due to the optical detection on different part of the moving object. In order to better keep track of the moving object, we need to filter out the small boundary boxes and keep the large boundary box. The other minor parameters such as the shape for the display of motion vector and tracking box are up for the users to decide.

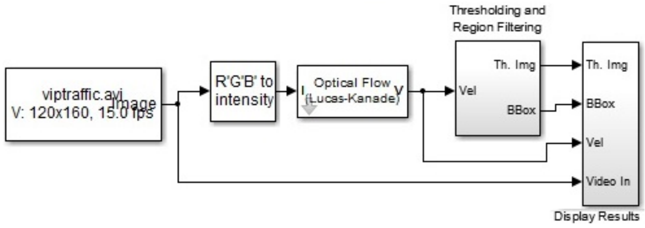

Figure 1: Simulink Block Diagram for Tracking Moving Objects Using Optical Flow

3. Methodology

The algorithm has following stages:

1) Feed a video file to be tracked as an input.
2) Convert color frames of video to grayscale video frames.
3) Compute optical flow between current frame and Nth frame back
4) From above step we can calculate velocity of motion vectors.
5) Out of all pixels of the frame only moving pixels are of moving object.
6) Compute magnitude of vector of velocity which can we get through optical flow & take a mean.

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7) Use median filter to get threshold image of moving object.
8) Perform blob analysis on thresholded.
9) After that box can be drawn around that image.
10) Moving object tracked in that box.

The main steps used are optical flow and thresholding, median filter and blob analysis.

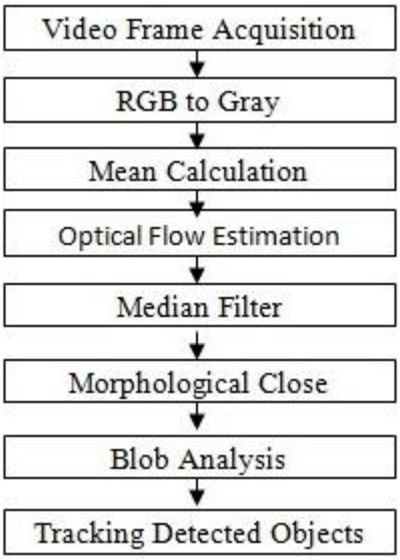

Figure 2: Block Diagram for Proposed Algorithm

A. Optical Flow

Optical flow method involves calculating the image optical flow field and doing clustering processing according to the optical flow distribution characteristics of image. This method can get the complete movement information of an object and it is useful for detecting the moving object from the background with the 85% accuracy, but this method has a few disadvantages including large quantity of calculations, sensitivity to noise, poor anti-noise performance, which make it not appropriate for real-time object detection and tracking. Optical flow estimation tries to assign to each pixel of the current frame a two-component velocity vector indicating the position of the same pixel in the reference frame. There are several optical flow estimation algorithms known in the literature. According to the taxonomy proposed in, we can cluster algorithms in the following categories: region-based matching, differential (Lucas-Kanade, Horn-Schunk) and energy-based algorithm. Optical flow method generates optical flow field for every pixel in sequential images, in which the velocity and direction of every pixel are obtained.

Estimation of Optical Flow:

Optical flow method generates optical flow field for every pixel in sequential images, in which the velocity and direction of every pixel are obtained. Given an image I and *I(x, y, t)* represents the gray value of pixel I(x, y) at time t. Let *(u, v)* represent the optical flow components of *I(x, y)*. Suppose that pixel *I(x, y)* at time t moves to $I(x + \Delta x, y+\Delta y)$ at time $t + \Delta t$, where $\Delta x = u*\Delta t$ and $\Delta y = v*\Delta t$, and the gray value of *I(x, y)* and $I(x + \Delta x, y + \Delta y)$ are the same. So we get the equation below:

$$f(x+\Delta x, y+\Delta t, t+\Delta t) = f(x,y,t) \qquad (1)$$

Using Taylor series expansion, the equation becomes

$$f(x,y,t)+\Delta x\frac{\partial f}{\partial x}+\Delta y\frac{\partial f}{\partial y}+\Delta t\frac{\partial f}{\partial t} = f(x,y,t) \qquad (2)$$

Divided by Δ t , and let Δ t tend to zero, then get the equation below:

$$\frac{dx}{dt}\frac{\partial f}{\partial x}+\frac{dy}{dt}\frac{\partial f}{\partial y}+\frac{\partial f}{\partial t} = 0 \qquad (3)$$

For simplicity of expression, give some variable definition.

let $u = \frac{dx}{dt}, v = \frac{dy}{dt}, f_x = \frac{\partial f}{\partial x}, f_y = \frac{\partial f}{\partial y}, f_t = \frac{\partial f}{\partial t}$

Then the optical flow constraint equation becomes

$$uf_x + vf_y + f_t = 0 \qquad (4)$$

In this equation f_x, f_y and f_t can be easily got from the image. And with other constraints, we can get the value of u and v. The moving speed of every pixel in axis x and y is got from optical flow method. If given two continuous frames, optical flow method can be used to calculate the moving speed and direction of every pixel that move from the first frame to the second frame. Dividing the whole region into eight sub-regions as shown in Fig. 1, we get eight moving directions. As shown in Fig. 2, region between two adjacent dotted lines belongs to the same direction. Given the target region, then the moving direction is determined by voting method.

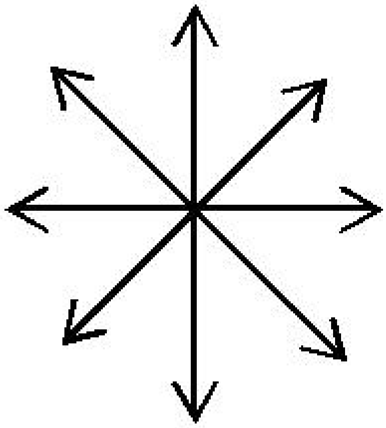

Figure 3: Eight sub-regions of the whole region

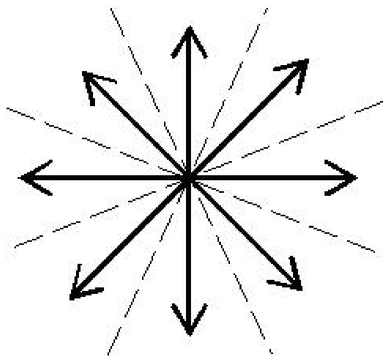

Figure 4: Direction Determining Method

B. Thresholding

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images.

1.) Method

During the thresholding process, individual pixels in an image are marked as "object" pixels if their value is greater

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than some threshold value (assuming an object to be brighter than the background) and as "background" pixels otherwise. This convention is known as threshold above. Variants include threshold below, which is opposite of threshold above; threshold inside, where a pixel is labeled "object" if its value is between two thresholds; and threshold outside, which is the opposite of threshold inside. Typically, an object pixel is given a value of “1” while a background pixel is given a value of “0.” Finally, a binary image is created by coloring each pixel white or black, depending on a pixel's labels.

2.) Threshold Selection
The key parameter in the thresholding process is the choice of the threshold value. Several different methods for choosing a threshold exist; users can manually choose a threshold value, or a thresholding algorithm can compute a value automatically, which is known as automatic thresholding value, the rationale being that if the object pixels are brighter than the background, they should also be brighter than the average. In a noise less image with uniform background and object values, the mean or median will work well as the threshold, however, this will generally not be the case. A more sophisticated approach might be to create a histogram of the image pixel intensities and use the valley point as the threshold. The histogram approach assumes that there is some average value for the background and object pixels, but that the actual pixel values have some variation around these average values.

C. Median Filtering

In signal processing, it is often desirable to be able to perform some kind of noise reduction on an image or signal. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical preprocessing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For 1D signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher dimensional)signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically.

D. Blob Analysis

In the area of computer vision, blob detection refers to visual modules that are aimed at detecting points and/or regions in the image that differ in properties like brightness or color compared to the surrounding. There are two main classes of blob detectors differential methods based on derivative expressions and methods based on local extreme in the intensity landscape. With the more recent terminology used in the field, these operators can also be referred to as interest point operators, or alternatively interest region operators.

There are several motivations for studying and developing blob detectors. One main reason is to provide complementary information about regions, which is not obtained from edge detectors or corner detectors. In early work in the area, blob detection was used to obtain regions of interest for further processing. These regions could signal the presence of objects or parts of objects in the image domain with application to object recognition and/or object tracking. In other domains, such as histogram analysis, blob descriptors can also be used for peak detection with application to segmentation. Another common use of blob descriptors is as main primitives for texture analysis and texture recognition. In more recent work, blob descriptors have found increasingly popular use as interest points for wide baseline stereo matching and to signal the presence of informative image features for appearance-based object recognition based on local image statistics.

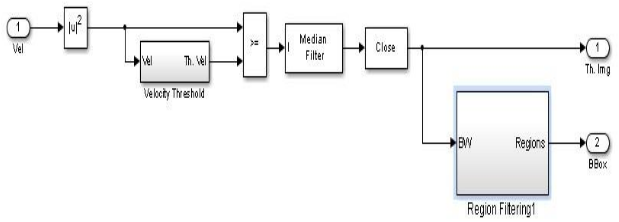

Figure 5: Simulink Block Diagram for Thresholding and Region filtering

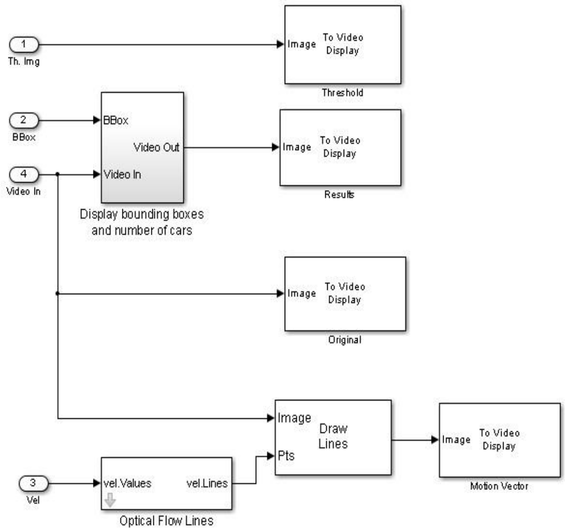

Figure 6: Simulink Block Diagram for Display Result

4. Result

(a) (b)

(c) (d)

Figure 7: An Urban Video Frame (a) Original input video frame (b) optical flow motion vectors, (c) binary image with blobs and (d) tracking motion vehicles with boundary boxes

Table I depicts the average processing times (in ms) of proposed framework when applied on a 120- frame-video and RGB(120× 160) Image format using matlab.

Table 1: Average Processing Time (in ms) of Various Stages Within Framework

Stages	Lucasanade	HornSchunk
Optical flow estimation	5.2	6
Filtering Segmentation	1.6	1.6
Motion Vectors Computing	.44	.58
Tracking + Count Number	11.3	11.3
Initializing and Finalizing	5534.4	6201.1
Total	5,552.9	6,220.5

5. Conclusion

This paper has presented a system for motion object detection and tracking in image sequences from aerial or stationary camera images. Traffic surveillance in the urban environment is one of the most applicable usages of this system. The proposed system employs several methods to detect, filtering, segmentation and tracking objects. We used Lukas- Kanade algorithm, as the most suitable method of optical flow estimation, to detect moving objects by the intensity changes of frames. The median filter performance significantly surpasses that of the other filters under study. The morphological close extracted significant features of region shapes from binary images and then blob analysis introduced these shapes to the next step s foregrounds. A great advantage of blob analysis is the low computation cost. Finally, as shown in the experimental result, the system is able to remove unwanted motion object which are not vehicles in the image sequence, using constraints on blob areas.

References

[1] Ould-Dris Nouar, Ganoun Ali, And Canals Raphaël , “Improved Object Tracking With Camshift Algorithm”, IEEE: 1-4244-0469-X, 2006.

[2] Xin Li ,Kejun Wang And Wei Wang and Yang Li, “A Multiple Object Tracking Method Using Kalman Filter”, International Conference on Information and Automation , IEEE: 978-1-4244-5704-5, June 2010

[3] Yi-Bo –Li and Xiao-Ling Shen Shan Shan Bei “Real-time Tracking Method for Moving Target Based on an Improved Camshift Algorithm”, International Conference on Mechatronic Science, Electric Engineering and Computer, IEEE: 978-1-61284-722-1, August 2011.

[4] Yuqiang Fang and Bin Dai “An Improved Moving Target Detecting and Tracking Based On Optical Flow Technique and Kalman Filter”, International Conference on Computer Science & Education, IEEE: 978-1-4244-3521, 2009.

[5] Hai-Yan Zhang “Multiple Moving Objects Detection And Tracking Based On Optical Flow In Polar-Log Images”, International Conference on Machine Learning and Cybernetics, IEEE: 978-1-4244-6527-9, 2010.

[6] Zhiwen Chen, Jianzhong Cao, Yao Tang and Linao Tang “Tracking of Moving Object Based on Optical Flow Detection”, International Conference on Computer Science and Network Technology, IEEE: 978-4577-1587-7, 2011

[7] Ya Liu, Yao Lu, Qingxuan Shi and Jianhua Ding “Optical flow based urban road vehicle tracking”, International Conference on Computational Intelligence and Security, IEEE: 978-1-4799-2548-3, 2013

[8] Sepehr Aslani and Homayoun Mahdavi-Nasab, “Optical Flow Based Moving Object Detection and Tracking for Traffic Surveillance”, International Journal of Electrical, Computer, Electronics and Communication Engineering Vol.7, No:9, 2013

[9] Manjunath Basavaiah,” Development of Optical Flow Based Moving Object Detection and Tracking System on an Embedded DSP Processor”, Journal of Advances in Computational Research: An International Journal Vol.1, No.1-2, 2012.

[10] Himani S. Parekh, Darshak G. Thakore , Udesang K. Jaliya ,” A Survey on Object Detection and Tracking Methods”, International Journal of Innovative Research in Computer and Communication Engineering Vol. 2, Issue 2, February 2014.

[11] Meha J. Patel, Bhumika Bhatt,"A Comparative Study of Object Tracking Techniques",International Journal of Innovative Research in Science,Engineering and Technology Vol. 4, Issue 3, March 2015

[12] Kinjal A Joshi, Darshak G. Thakore,"A Survey on Moving Object Detection and Tracking in Video Surveillance System",International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-2, Issue-3, July 2012.

[13] S.A.Tiwaskar, "Survey on Object Detection from Video Sequence", International Journal for Research in Emerging Science and technology, Vol.1, Issue 6, November-2014.

[14] Gottipati. Srinivas Babu, "Moving Object Detection Using Matlab" ,International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 6, August – 2012 ISSN: 2278-0181