A Robust Algorithm for Real Time Tracking With Optical Flow

C. Karthika Pragadeeswari, G.Yamuna, G. Yasmin Beham

Abstract: Object tracking is a troublesome undertaking and significant extent in data processor perception and image handling community. Some of the applications are protection surveillance, traffic monitoring on roads, offense detection and medical imaging. In this paper a recent technique for tracking of moving object is intended. Optical flow information authorizes us to know the displacement and speed of objects personate in a scene. Apply optical flow to the image gives flow vectors of the points to distinguishing the moving aspects. Optical flow is accomplished by Lucas canade algorithm. This algorithm is superior to other algorithms. The outcomes reveals that the intend algorithm is efficient and accurate object tracking method. This paper depicts a smoothing algorithm to track the moving object of both single and multiple objects in real time. The main issue of high computational time is greatly reduced in this proposed work.

Keywords: Computer Vision, Lucas Canade Algorithm, Object Tracking Optical Flow Technique.

I. INTRODUCTION

Moving target tracking is to determine locations that the same object from different frames in image sequences. When moving object is correctly detected, the tracking is equivalent to the characteristics matching problem. The characteristics are created in consecutive image frames based on location, velocity, shape, texture, color and so on. Moving object tracking is a very considerable subject in the extent of data processor vision. It is the premise of the object detection and the cognizant behavior analysis. The robust object detection is a necessary undertake for the precision of subsequent object tracking and comportment analysis.

Many object detection algorithms have been intended, such as temporal differencing, frame difference method background subtraction method, optical flow method and so on.

Temporal differencing [1] taken into account dissimilarity in two succeeding frames with esteem to time. It is primarily same as background subtraction technique to subtract the image fetters target information through threshold value. It is very quiet to implement but it is lack of significant pixels of some types of moving object and cannot used in real time implementations.

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Frame difference method [2] is a simple algorithm, in that dispute between two successive frames obtained and the object can be recognized by this method and is tracked by template matching algorithm. This system is cost effective and utilizes a supervision tool in distinct applications.

Background subtraction method [3] is used to subtract the current frame from background taken as reference and various background subtraction models are analyzed and compared with their capability, reminiscence and fidelity. It is the prime method for extended applications.

Optical flow technique characterized as the changes in the movement of object with respect to brightness pattern in image. Optical flow computes the motion between two frames for every pixel in the frame which are taken at different time intervals. Optical flow is extensively used technique to track the moving objects efficiently. This method is capable of providing complete movement information and detects the moving object from the background better than the other methods. However this method is useful in object tracking. The main work of target tracking is to select good target characteristics.

Determining an optical flow [4] is quiet important. A technique for evaluating the optical flow instance is demonstrated which appropriates that alters in location analogous to brightness pattern. It readily varies at any place in the image. A repeating performance is denoted which satisfyingly projects the optical flow for several criterions in image sequences. The algorithm is incredibly rapid and additionally unfeeling towards quantization of contrast levels and additive noise.

Prediction and Tracking of Moving Objects in Image Sequences [5] that we utilize a forecast model for movement of object velocity and area estimation got from Bayesian hypothesis. Segmentation and optical flow tracking is used for predicting future frames. The proposed algorithm provides good moving object tracking capabilities. Such capabilities are used for segmenting and estimating the moving object velocity and segmentation in a future frame.

Optical Flow Based Moving Object Detection and Tracking for Traffic Surveillance [6] that trusting on optical flow can be through Horn Schunck algorithm. To evacuate clamors, median filter is utilized and the undesirable objects are excluded by applying Thresholding calculations in morphological tasks. The outcomes prove that the framework powerfully recognizes and tracks moving aspects in urban video and evacuates the undesirable objects which are not vehicles.

A Surveillance System Based on Motion Detection and Motion Estimation utilizing Optical Flow [7]that higher density flow vectors movement are kept in a video sequence without using any filter out operations. It has higher precision and fulfilled in Horn Schunck algorithm but it will not import in 3D motion.

Motion Detection Using Horn Schunck Algorithm and Implementation [8] by examining an optical flow image that the optimal parameters resembling smoothness, iteration compactness for other types of displacements like trivial, medium, huge has to be evaluated by utilizing an Horn Schunck algorithm.

Moving Object Tracking using Optical Flow and Motion Vector Estimation [9] that moving object detection and tracking is an developing exploration field since it has vast applications in traffic inspection, 3D observation, movement investigation (human and non-human), activity recognition, therapeutic imaging etc. designing a modern object perception and tracking algorithm which utilized optical flow belongs to motion vector estimation for object detection and tracking in a successive frames. The optical flow gives significant information about the object movement regardless of whether no quantitative parameters are processed. The motion vector estimation strategy can provide an estimation of object position from successive frames which built the exactness of this algorithm and helps to provide robust result independent of image obscure and changing background. The necessity of median filter with this algorithm constitute it more rapid in the presence of clamor but the intended tracker finds out the human with trivial movement and precisely the moving shadow of the same person as a moving object.

Performance of Optical Flow Technique [10] considering a strategies for a model obstruct of real and standard image consecutives. The outcomes of various routinely issues alluded to optical flow techniques enclosing a model of differential matching energy based and phase based methods are accounted. Our comparisons are basically experimental and focus on the accuracy, dependability and density of the speed measurements they demonstrate that performance can vary essentially among the methods we implemented.

Segmentation of Vehicles Based on Motion Estimation[11] that by applying an Lucas canade algorithm to evaluating the displacement vectors to identify the motions in custom to separate the vehicles from background using threshold operation and the movement of vehicles can be tracked by using blob in a video sequence.

Comparative Analysis of Face Tracking [12] that uses a different face tracking algorithms like CAMSHIFT and Canade Lucas Tomasi to detect and extract the feature points.CAMSHIFT algorithms fails in indoor environment and falsely track in similar background color but Lucas canade are fit for all because of evaluating the displacement vectors and it proves improved accuracy.

By applying an optical flow algorithm to recover the problem of left ventricle of human heart based on ultrasonic image data [13] that optical flow method as a semi-automatic contouring algorithm by using an Lucas canade algorithm to track the contouring of left ventricle it is not an easy task not done by any segmentation, filtering and other morphological transformations. By applying Lucas canade it gives positive results and it has reduced computation time and better accuracy.

Though an algorithm developed [14] to track single objects using velocity vectors is available but the algorithm resistant for real time applications. The evaluation of parameters of moving object such as speed, direction, velocity, displacement of the moving target is not done. Hence this proposed technique is aimed to work in real time applications and can solve the main issue of high computational value.

The optical flow visualize the path and time pixels in a sequence of two resultant dimensional speed vectors, carrying direction and the speed of movement to attribute each pixel in a stated location of the image. The tracking algorithm is purpose to track multiple moving objects in the input video. We intend a Lucas-Canade approach assumes that the flow is really fixed in a regional proximity of the pixel under consideration, and calculating that fundamental flow equations for each pixels in that proximity, using least squares rule.

Apart from, Lucas canade can also be implemented to track the multiple objects efficiently. Compared to Horn Schunck algorithm it is a local method gives the interior information in a image and it has improved accuracy. Lucas Canade not only to track the multiple objects in static camera but also it fits for to multiple objects in moving camera. It works in real time applications.

II. PROPOSED WORK

Optical flow method aims to compute a velocity vector for each pixel in the image and the whole image is analyzed through the velocity vector, for example, the velocity vector of the background and the moving object is different and it can be extracted by the difference of the velocity vector. The schematic block of Lucas canade algorithm as shown in fig.1. The optical flow field is explained as speed vector field of distinct motion of contrast pattern for a sequence of images. It is supposed that the movement of the brightness instance is the effect of relevant movement, huge enough to roll a deviation in spatial arrangement of intensities on the images.

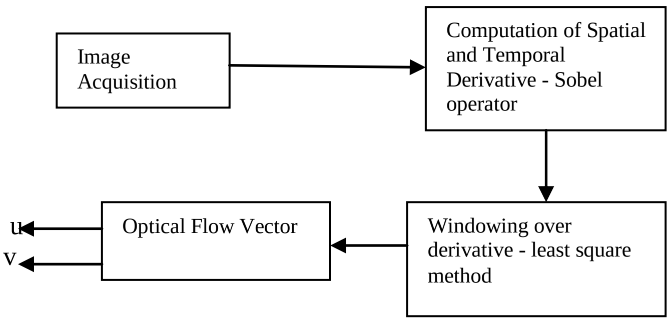

Fig 1. Schematic Block of Lucas Canade Algorithm

The Lucas–Canade method is an extensive algorithm which utilizes differential method for optical flow calculation and data processor recognition. This method proceeds with underlying optical flow equations for each pixel in that proximity, by the least squares criterion. It is a purely sectional method because it cannot provide flow information in the inward of homogenous provinces of the image.

Here it is appropriate that the flow is really perpetual in a local vicinity of the pixel under examination. The beneficial and drawback of Lucas Canade method is: benefits - this method is smooth compared to another method, very steadfast calculation and accurate time derivatives. Drawback - errors on boundaries of moving object.

The Optical Flow vectors with the components 'u' and 'v' for each proximity are computed by approaching windowing concept. Since Lucas - Canade theory appropriate that each pixels in an m×m window have the same speed components, this feature permit us to decide how massive the windows size is. To accomplish good results and to elude clamor, proximity window must be tuned in both Least squares windowing approach.

A. Image Acquisition

It is the process of retrieving an image from any source. In order to arrest an image a camera needs some kind of moderate resolution. The spirit of interest in this firm is light or more commonly electromagnetic waves. The Image procurement process comprise of three steps:-

1. Optical system which converge the power.
2. Energy reflected from the aspect of interest.
3. A sensor which values the amount of resolution.

B. Computation of spatial and temporal derivative

Sobel Operator is severe to find out the amount of the dissimilarity by locating the gradient matrix over each pixel of our image and sustain the intensities of a respective edge. As the center row of mask is comprise of zeros so it does not contain the primitive values of edge in the image but rather it count the dissimilarity of above and below pixel intensities of the respective edge. Thus incrementing the abrupt deviation in their intensities and making the edge more perceptible.

C. Least square method

By utilizing sobel edge detection the spatial and transient derivatives are computed. After finding the derivatives, optic flow vectors with the components u and v for each proximity are computed by utilizing Least squares method and its equations are,

$$\begin{bmatrix} \sum Ix*Ix & \sum Ix*Iy \\ \sum Ix*Iy & \sum Iy*Iy \end{bmatrix}^{-1} \begin{bmatrix} \sum Ix*It \\ \sum Iy*It \end{bmatrix}$$

To compute the u and v this satisfies these equations as,

$$\min \sum_{t} \left(f_{xt} + f_{yt} + f_t \right)^2$$

Taking the error of pixels and square to minimize the square error called least square fit.

D. Lucas canade algorithm

Step 1. Loop over frames and features

The procedure is considered for a single pixel (using its surrounding window) in two consecutive image frames and it is need to wrap as in step2 for loops, over frames in the sequence and over features (sparse pixels) in the image.

Step 2. Interpolate

After very first iteration, *x* and *y* can be floats; same for *u* and *v* and could simply round to nearest integer before computing. But results are more accurate if we interpolate.

Step 3. Detect features lost

Problem: If feature changes appearance too much, it has probably drifted onto another (occluding) surface in the scene. Solution: Check the residue by computing Sum of square differences of feature window in both I rows and J columns.

Step 4. Detect good features

Lucas-Canade could be utilized to calculate the movement for each pixel in the image. But motion of nearby pixels is similar. Pixel motion cannot be computed in areas of little (or no) texture.

Solution: First detect good features (pixel windows), then only track those features.

Step 5. Smooth the image to handle large motions. Motion between consecutive image frames can be large

Solution: Smooth the image first smoothing is already in gradient computation, so just use large s. But large s leads to less accuracy.

Solution: Sequentially decreases pyramid makes this computationally efficient.Recall scalar equation was derived by linearizing function about current estimate

$$\begin{bmatrix} I_x & I_Y \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} \approx -I_t \text{ +higher order terms}$$

Total displacement that we want (u).

Reinterpret:

$$\begin{bmatrix} I_X & I_Y \end{bmatrix} \begin{bmatrix} u\Delta \\ v\Delta \end{bmatrix} = -I_t$$

Incremental displacement that we compute (uΔ).

This is the one iteration of Newton's method. So we iterate and accumulate

$$u = u_0 + u_\Delta^1 + u_\Delta^2 + u_\Delta^3 + \ldots\ldots\ldots$$

Initial estimate could be zero.

1 D Lucas canade tracking:

For 1D:

$$I_x u_\Delta = -I_t$$

$$I_x = \frac{rise}{run} = \frac{-I_t}{u_\Delta}$$

First iteration:

1. Given two images and position x as shown in fig2.
2. Compute temporal derivative.
3. Compute spatial derivative.
4. Compute incremental displacement as shown in fig3.
5. Shift I(x) to the right by uΔ or shift J(x) to the left

to the uΔ as shown in fig 4 and fig 5.

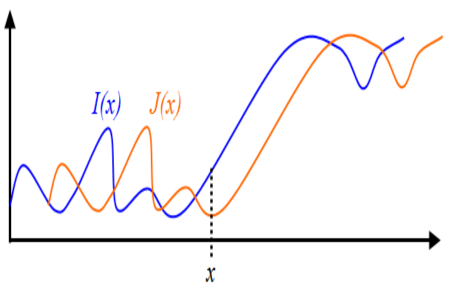

Fig.2 Given two images and position x

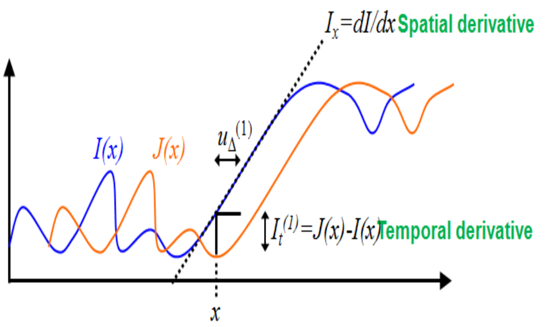

Fig.3.Computation of incremental displacement

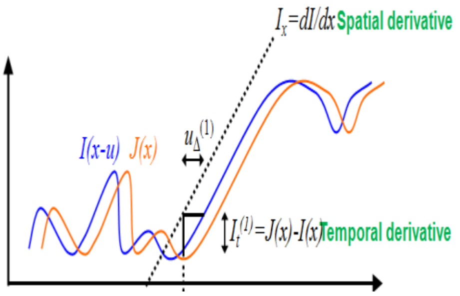

Fig.4. Shifting of I(x) to the right by u_Δ

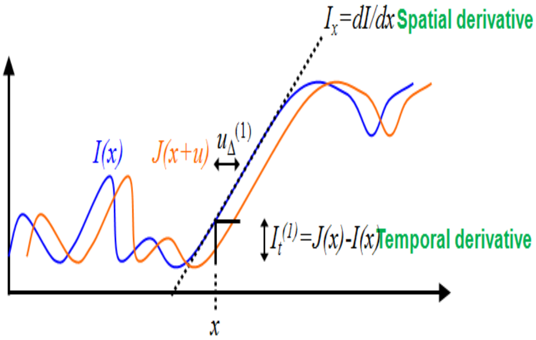

Fig.5 Shifting of J(x) to the left by u_Δ

Second iteration:

Repeat same steps until convergence as shown in fig6.

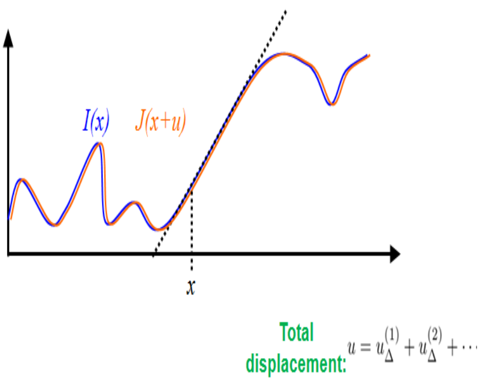

Fig.6 Convergence of Frames

For 2D Lucas canade in a nutshell:

$$\begin{bmatrix} I_x & I_y \end{bmatrix} \begin{bmatrix} u_\Delta \\ v_\Delta \end{bmatrix} = -I_t$$

Instead of solving for u u_Δ we need to solve f or u_Δ

$u_\Delta = (u_{\Delta,} v_\Delta)$

1. Given two consecutive images I and J from the sequence.
2. Take pixel wise difference between them I_t .
3. Compute gradient of one image I_x and I_y .
4. Sum over window to get Z and e.
5. Solve Z u_Δ =e for u_Δ .
6. Update u= $u_\Delta^1 + \ldots$
7. Shift image.
8. Repeat the steps.

III. RESULTS AND DISCUSSION

This section provides the details about the results of motion tracking. It also describes the use of optical flow concept in real time applications like video surveillance. Implementation of developed algorithm has been tested with a cat image with fifty frames under MATLAB platform. Velocity vectors are obtained and shown in fig. 7. Speed values are obtained in this proposed work which is illustrated in fig.8. This algorithm also meets the requirements of real time application and accuracy.

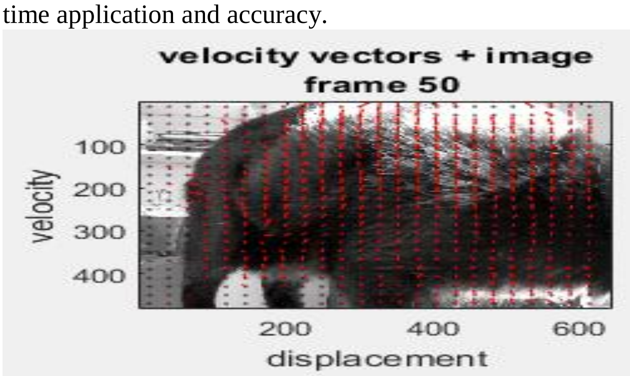

Fig.7 Compute Velocity and Displacements of cat Image

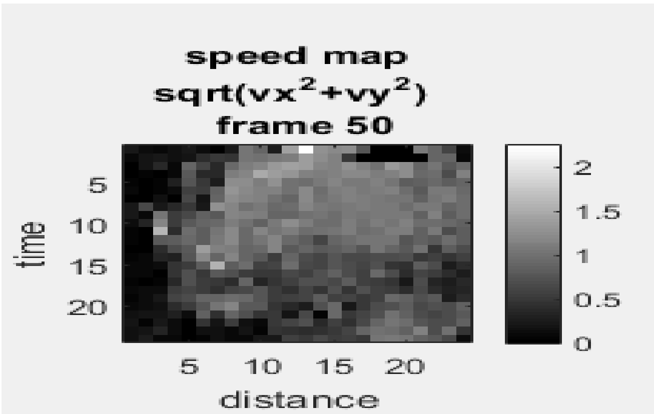

Fig 8. Computation of Intensity on Lucas Canade Algorithm

Compute the velocity and displacements of 50 frames and their intensity are calculated using our proposed algorithm. By using proposed algorithm the following parameters are estimated. The following parameters like velocity, Displacement, speed, direction and computation time. Displacement and Velocity values for single moving target is obtained and shown in Table - I for some frames.

VELOCITY:

It can define as the ratio of shift in the place of the aspect with esteem to time. Its unit is meter per second.

Velocity= $\frac{A_f - A_j}{t} = \frac{\Delta_m}{t}$

A_f = final position

A_i =initial position

t=time in seconds

Δ_m = change in position

DISPLACEMENT:

It can be defined as difference in final position to the initial position. Its unit is meter because the displacement formula comes under velocity.

Displacement=velocity*time

=final position-initial position

$= A_f - A_j = \Delta_m$

SPEED:

It can be defined as the ratio of distance travelled by an aspect as function of time. Its unit is meter per second.

Speed= $\frac{distance}{time}$

DIRECTION:

Direction can be evaluated by considering the values of velocity and displacement.

1. If the values are positive the object moves in forward direction.
2. If the values are negative the object moves in backward direction.

COMPUTATION TIME:

Considering a single object for 51 frames and has a computation time of 18.63millisecond. For multiple object 79 frames are taken and has a computation time of 102.8342 millisecond.

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Table - I: Displacement and Velocity of Some Frames

Displacement in(m)	Velocity in(m/sec)
-0.022	-0.0109
0.0258	0.0155
-0.0199	-0.0273
0.1444	0.0251
-0.0691	-0.0072
-0.0143	0.005
0.0374	-0.0055
-0.0402	0.007
-0.0212	-0.0013
0.0596	-0.014
-0.0526	0.0067
0.0269	-0.0037
-0.0931	0.0239
0.0496	-0.0057
0.0258	-0.0002
-0.0616	-0.0078
0.0577	0.0072
0.0447	0.002
-0.1324	0.0015
0.0126	0.0139
-0.099	0.007
-0.0541	-0.0006
0.0389	-0.0021
0.0424	0.0014
0.1325	-0.0028

For Multiple object detection the output is as shown as

Frame Number 25

Frame Number 52

Frame Number 62

Frame Number 71

Fig .9. Output for the Detection of Multiple Objects with Their Respective Frames and their Corresponding Binary Result

From that frame number 25,52,62,71 corresponds to tracking result of single person, multiple persons, as in Fig. 9 converging two persons, person take diversion and their corresponding binary results respectively.

Table -II: Calculating the Speed of Respective Frames

Frame number	Speed of moving objects in (milliseconds)
25	62
52	52
62	16
71	-11

From that Table II shows that tracking result of multiple objects and identifying the respective speeds. For that negative sign that particularize the person (P) deviating their path as shown as frame number 71. By the corresponding values in respective frames, either increasing or decreasing depends upon forward and backward movement as shown in Table II.

Table- III: Computational Time and Number of Frames for Single and Multiple objects.

Objects	Number of frames	Computation Time in(ms)
Single	51	18.63
Multiple	79	102.8342

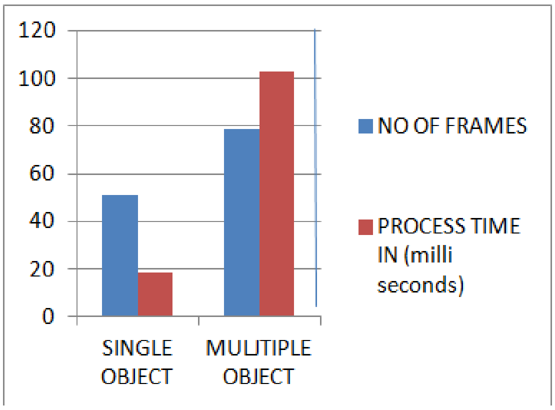

Fig 10: Bar Diagram of Single and Multiple Objects in Terms of Frames and process time.

For Single Object Detection, 50 frames are taken and process time is 18.63milliseconds and for multiple objects 79 frames are taken and the process time is 102.8342 milliseconds as illustrated in Fig 10. On the average the computation time for each frame is 0.365 ms as shown in the Table - III.

CONCLUSION

In this paper, tracking the moving object is done in consecutive video frame taken from the static camera. In every succeeding frame initially the average flow vectors are estimated and then the formation of optical flow vectors takes place. For the improved accuracy Lucas-canade algorithm has been preferred for the valuation of optical flow because of its high accuracy and its basic principle that uses the deviation of intensity between two progressive video frames for motion cognition. For the moving object the displacement and velocity can be calculated which helps in finding the speed of the moving target and the direction of the object can be obtained from the video sequence. This robust algorithm also supports real time tracking. The same can be tried for moving camera applications.

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