Using Object Tracking Methods to Calculate Vehicular Speed : Contrast and Review

Nidhi V. Gada
Bachelors of Information Technology
KJ Somaiya College of Engineering
Mumbai, India

Vidhi R. Chitalia
Bachelors of Information Technology
KJ Somaiya College of Engineering
Mumbai,India

Sunayana V. Jadhav
Assistant Professor (IT Dept)
KJ Somaiya College of Engineering
Mumbai, India

Abstract:- Congestion is an extreme issue in India as the quantity of vehicles have expanded altogether since couple of years, as it is a noteworthy concern which adds to the street activity. The Developing Vehicular Populace, has prompt infringement of speed limits. To check this issue, distinctive nations have different methods to recognize and track vehicles. Essentially, in India we have different techniques like Kalman Filter and Lucas Kanade which can be utilized. Using the above two methods, we gauge the speed utilizing a succession of video pictures from an uncalibrated camera. Subsequent to contrasting both the techniques, the outcomes from error rate will give us a thought which calculation is more appropriate.

Keywords:- *Object Detection, Object Tracking, Displacement, Background Subtraction, Speed.*

I. INTRODUCTION

As of late it gets an incredible thoughtfulness regarding decrease street mishap and controlling movement by restricting the speed of vehicles. Speed estimation is one of the pivotal issues in traffic surveillance. Up until now, the field is overwhelmed by radar and segment speed estimations since they meet the methodological gauges and prerequisites. To overcome these out of date strategies, we have run over the picture preparing procedures that can be utilized to control the over-speeding vehicles by recognizing their speed. Unlike CCTV, where the camera is aligned and situated at a particular stature and edge to catch a moving vehicle, we can rather utilize a versatile camera for horizontal view of the road and the distance from the ground. Here, we will just focus on the differential techniques which are Lucas Kanade and Kalman Filter which is achieved on 64-Bit 2017b MATLAB, Simulink and Polyspace Product Families by Mathworks. It is beneficial for secure transportation, eschewing road accidents, controlling the speed limit etc. Correlation is influenced in view of the optical stream to design, division of the movement of the pictures, speed and the handling time.

Section II provides you with the Literature Review. A brief discussion about the project will be covered in section III which is Proposed Methodology. Section IV gives an idea about the Speed Calculation Technique. Conclusion will be drawn from the above given part in Section V. Future Scope is included in Section VI.

II. LITERATURE REVIEW

A. Lucas Kanade

Lucas Kanade technique is generally utilized for differential strategy of optical stream. It evaluates the development of intriguing highlights in progressive pictures of a scene. It expects that the stream is for the most part steady in nearby neighborhood of pixel under thought.

It mounds only on nearby data which is the resultant from small window close to each purpose of interest.

Consider an image I (x,y) experiences a displacement (u,v) where u and v demonstrates the uprooting of the pixel. There are two limitations which are imperative will be utilized to explain the condition of dislodging. They are Brightness Constancy Constraint where it is assumed that all the pixel have steady brightness through all the frame and another is Spatial Coherence Constraint where all the neighbour have a similar displacement. The optical flow equation is given below to find the pattern of motion between the spectator and the location.

$$I_x u + I_y v + I_t = 0 \qquad (1)$$

After the partial derivative of the image with respect to time and position is calculated, using the Least Square Principle, a solution is obtained to give the following.

$$\begin{bmatrix} V_x \\ V_y \end{bmatrix} = \begin{bmatrix} \sum_i I_x(q_i)^2 & \sum_i I_x(q_i)I_y(q_i) \\ \sum_i I_y(q_i)I_x(q_i) & \sum_i I_y(q_i)^2 \end{bmatrix}^{-1} \begin{bmatrix} -\sum_i I_x(q_i)I_t(q_i) \\ -\sum_i I_y(q_i)I_t(q_i) \end{bmatrix} \qquad (2)$$

B. Kalman Filter

Kalman Filter is the most broadly utilized and dependable technique for foreseeing the condition of state of noise of sample system. It utilizes a dynamic model. It gauges the system's varying quantities i.e. its state by knowing the numerous consecutive estimations and control contributions to the system. It is a discrete time linear dynamic system. It depends upon two equations:

$$x_k = Ax_{k-1} \quad (3)$$

The above equation indicates how the system change with each time x_k alludes to the state of the system at the time k step k state of system which is simply matrix of values because it defines how the system behaves and conforming with standard model. The three quantities used to depict a moving object are position, velocity and acceleration. Here, matrix is used to describe the operation used on previous state to calculate the current state

$$z_k = Bx_k \quad (4)$$

The second equation manages how the deliberate estimation of a system represented here relates to the x_k that is used in prediction calculated by the first equation in a noiseless system x_k and x_k where B is an identity matrix.

C. Blob Detection

A Blob Analysis algorithm is utilized to discover and tally objects, and to make fundamental estimation of their attributes. The motivation behind analysis is to decide if the outcomes acquired from a task are precise, logical and genuine. It contains complex calculations that have pixel esteems as inputs. The calculation perceives pixels by their value and places them in one of two classifications viz. foreground (normally a pixel has a non-zero value) or the background (pixels with a zero value). In the event that the picture contains a few superfluous blobs, we ought to pre-process the picture before utilizing it. Preprocessing alludes to any means made to tidy up the picture before analysis and can incorporate thresholding or separating. Any piece of a blob that is in background pixel state as a result of lighting or reflection is considered as background amid analysis. The execution of a blob analysis task relies upon an effective segmentation of the picture that is, isolating the great blobs from the background and additionally dispensing with everything else in the picture that isn't premium.

D. Related Works

Shalaka S. Wardha [1] presented a a technique for vehicle speed measurement and vehicle tracking. Mathematical formulations are achieved for speed calculation based on the number of frames, frame rate & distance traversed by vehicle.

[9] described an algorithm to evaluate the real time speed of vehicles from the known camera calibration parameters using image processing techniques. The frame differencing technique is applied on the moving vehicle, the object tracking procedure is executed and speed is calculated using the displacement of the centroids.

[11] used sequence of images to estimate the speed of the vehicle by an uncalibrated camera where the parameters are known prior to the execution. Estimation of speed doesn't require precise calibration but some common inference which reduce complex structure.

III. PROPOSED METHODOLOGY

The proposed technique figures the speed of the moving vehicle by utilizing two calculations i.e Kalman Filter and Lucas Kanade. The strategy right off the bat will detect and track the vehicle. Utilizing Blob Analysis, the vehicle will be followed and arranged under background or foreground image. The extricated grayscale picture will fill in as a input to the algorithm. After the techniques are connected, the speed will be computed based on data gained from the calculations. The speed obtained by both the techniques will be compared based on their exactness w.r.t the real speed obtained from the speedometer. Fig 1. shown below is a summed up stream graph which will be trailed by both the algorithms.

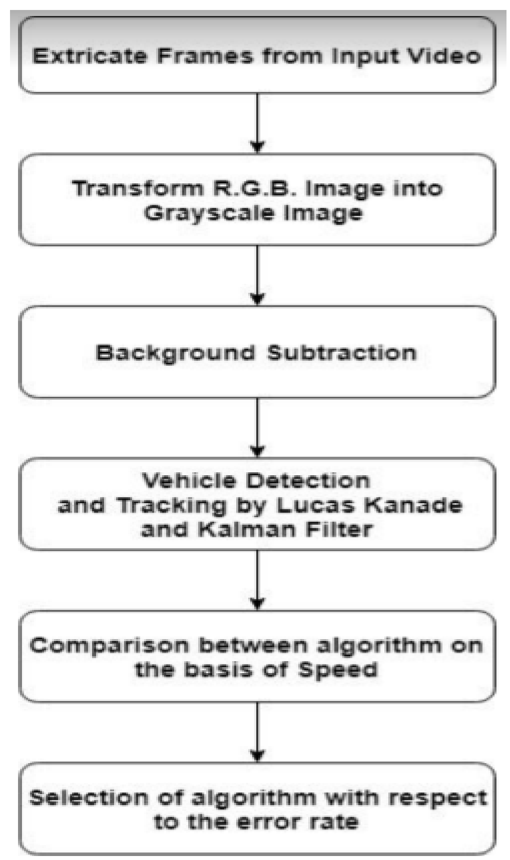

Fig 1:-

A. Lucas Kanade

Lucas Kanade method uses an optical flow calculation which gives an approximation of the movement of vehicles in progressive pictures of a scene. The two edges get isolated by a specific time augment in a way that vehicles have not dislodged remarkably. The frames depict continuous vehicles revealing shades of gray which change equitably.

Grouping of pixels into background or foreground is given by the closer view objects which are distinguished from a video arrangement. Background Model's viewpoint is represented by object recognition activity. The logic behind drawing closer in such a path is that, the recognition of the moving vehicles is the distinction between reference frame and current frame.

The optical flow methods try to calculate the motion between two image frames which is mentioned in equation (1). Encompassing pixels are regularly used to respond the movement of the central pixels by setting up an arrangement of equations and these equations can be composed as a matrix. Least Square Principle is used by this calculation which yields us a trade off solution. Later, when the estimations of u and v are acquired, we can compute the velocity vector (Vx and Vy) as given in equation (2).

- *Vehicle Detection and Tracking*

The recordings are taken by using a static camera. Some pre-processing activities must be done to make the motion picture ready to process. Grayscale design is chosen because of the impact of intensity changes and the auto white adjust of the camera. General external clamors induced because of climate conditions is a standout amongst the most essential piece of the technique. Median Filter is utilized as a part of our structure. Morphological closing is executed to fill the openings created amid the filtering procedure. In the time grouping of two resulting frames, optical flow portrays the course and time rate of the pixel. As the movement of objects are detected, blob examination is executed which clusters the items, objects which aren't vehicles based on blob sizes Bounding Boxes around the vehicle which is shown in Fig 2.

Fig 2:-

B. Kalman Filter

Kalman Filter algorithm is utilized to assess the state of linear system at every pixel index which tracks the pixel intensity at the similar point. The equations for the algorithm falls into two categories: Time measurement equations (Predict) i.e. obtaining the estimate for the next step by calculating the error covariance with current state which is calculated using equation (3) and second the Measurement update equation (Update) which can be considered as corrector equation with the help of equation (4). Regularly, the two stages alternate, propelling the state until the following scheduled perception, and the update joining the perception. Kalman Filter is recursive i.e. it includes the system information from the past without storing it.

The background is resolved to decrease a portion of the issue that shows up from the standard strategy. Pixel by pixel intensity analytical assessment scheme is one of the least complex approach. Local time development, local structure and feedback are the essential order of background estimation strategies. The background gets secured with the foreground picture by setting a threshold intensity and thus a spotless closer picture is acquired.

- *Vehicle Detection and Tracking*

Vehicle Identification is event of semantic objects of a specific class i.e. vehicles in this specific circumstance and vehicle tracking is foreseeing it's situation from its past data. After the background subtraction, frame number is chosen from where the tracking should begun. Every conditions of time and estimations have been applied and furthermore, the centroid is computed. Gathering of all the neighboring pixel is done and after that an enclosure is drawn each casing around the assembled foreground pixels. The centroid moves as the frame is moving which helps us in calculating the displacement of the vehicle. All the above advances are performed on the grayscale picture which diminishes the commotion in the back to back frames and corresponding RGB frame is shown in Fig 3. Box has been drawn in each frame which demonstrates the direction of the selected moving object.

Fig 3:-

IV. PROPOSED SPEED CALCULATION TECHNIQUE

Utilizing the above two algorithms, we will ascertain the speed of moving vehicle. The Bounding Box are in the shape of rectangle so it is easy to figure out the centroid of the box i.e vehicle. Centroid is calculated in X as well as in Y direction (Cx ,Cy). After a certain distance is travelled, various centroid esteems are computed.

$$D = \sqrt{(x2 - x1)^2 + (y2 - y1)^2} \quad (5)$$

The vehicle travels distance in vertical and horizontal direction using the Distance Formula shown above. The speed of the vehicle is assessed by the distance calculated by the above formula and time. Time is calculated by transforming the frame rate. Speed is detailed as

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} \quad (6)$$

The speed acquired from both the algorithm is contrasted and the speed is estimated utilizing the speedometer. As indicated by our perception, the error rate obtained through Lucas Kanade and Kalman Filter is shown below in the table.

Live Video	Car	Speed By lucas Kannade	Error	Speed By Kalman Filter	Error
1	1	57	25	55	20
	2	62	11	65	8
	3	51	10	54	9
2	1	59	18	61	16
	2	77	11	80	10
	3	62	15	65	13
3	1	40	30	45	25
	2	54	20	57	19
	3	77	11	81	13

This influences us to arrive at the conclusion that Kalman Filter is superior to Lucas Kanade.

V. CONCLUSION

An effective system for evaluating the speed of moving vehicles on a street has been created utilizing an uncalibrated camera. The camera catches the video of vehicles which is later prepared to create compelling outcomes. The image processing approach has been utilized to identify and track the vehicles from the video frames. These detection and tracking of vehicles in a video has been employed using two algorithms. While considering these calculations, the speed of the following vehicles is resolved. The coveted genuine speed of the vehicle is known in advance. A correlation between the speed acquired from both the algorithms is introduced to decide the best approach. Fig 4. of Lucas Kanade and Fig 5. of Kalman Filter demonstrates the closer view picture of the vehicle. This gives a reasonable thought that Kalman Filter has expelled greatest noise improving it to ascertain the tracked object. An examination between the speeds obtained from both the algorithms is presented to determine the best approach which is Kalman Filter.

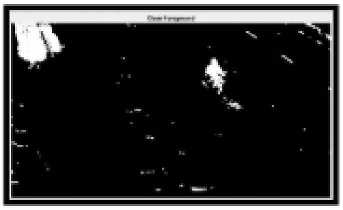

Fig 4:-

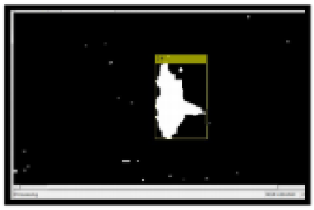

Fig 5:-

VI. FUTURE SCOPE

This system centers around computing the speed of vehicles by figuring their accuracy, efficiency and unwavering quality. For better outcomes, we can broaden the above proposed system by building a database having the individual personal details of the drivers, their vehicles and the vehicle number plate enrolled under the legislature. Utilizing the Speed Estimation module from our framework alongside the new system to be ordered The Vehicle Number Plate Detection; we can force a levy to the drivers breaking the speed limits in the city. This new system will relax the administration's concern of pedestrian safety which in turn will end the infringement of traffic laws by the drivers.

REFERENCES

[1]. Shalaka S. Wardha , Prof. S. M. Deokar, Prof. S. S. Patankar, Prof. J. V. Kulkarni , “Development of Automated Technique for Vehicle Speed Estimation and Tracking in Video Stream ”, 2017 2nd IEEE International Conference On Recent Trends in Electronics Information & Communication Technology (RTEICT), May 19-20, 2017, India.

[2]. Archita Tah1 , Sudipta Roy , Prasenjit Das and Anirban Mitra1 “Moving Object Detection and Segmentation using Background Subtraction by Kalman Filter ” Indian Journal of Science and Technology, Vol 10(19), DOI: 10.17485/ijst/2017/v10i19/95427, May 2017.

[3]. Mohammed Reduanul, Md. Golam Moazzam, Saiful Islam, Rony Das, Mohammed Shorif Uddin, “Vehicle Speed Determination from Video Streams using Image Processing ”, 2016 International Workshop on Computational Intelligence (IWCI) 12-13 December 2016, Dhaka, Bangladesh.

[4]. Pratishtha Gupta, G N Purohit,Manisha Rathore, “Estimating Speed of Vehicle using Centroid Method in MATLAB ”,International Journal of Computer Applications (0975 – 8887) Volume 102– No.14, September 2014.

[5]. Asif Khan, Imran Ansari, Dr.Mohammad Shakowat Zaman Sarker and Samjhana Rayamajhi, “Speed Estimation of Vehicle in Intelligent Traffic Surveillance System Using Video Image Processing”, International

Journal of Scientific & Engineering Research, Volume 5, Issue 12, December-2014.

[6]. Ms. Bhagyashri Makwana, Prof. Pravesh Kumar Goel, "Moving Vehicle Detection and Speed Measurement in Video Sequence", International Journal of Engineering Research & Technology, ISSN: 2278-0181, Vol 2.0 Issue 10th October-2013.

[7]. Sepehr Aslani, Homayoun Mahdavi-Nasab "Optical Flow Based Moving Object Detection and Tracking for Traffic Surveillance" World Academy of Science, Engineering and Technology International Journal of Electrical and Computer Engineering Vol:7, No:9, 2013.

[8]. H. A. Rahim, U. U. Sheikh, R. B. Ahmad and A. S. M. Zain, "Vehicle Velocity Estimation for Traffic Surveillance System", World Academy of Science, Engineering and Technology International Journal of Transport and Vehicle Engineering Vol:4, No:9, 2010.

[9]. Lee Yee Siong, Siti Salasiah Mokri , Aini Hussain, Norazlin Ibrahim, Mohd Marzuki Mustafa5, "Motion Detection Using Lucas Kanade Algorithm and Application Enhancement ", 2009 International Conference on Electrical Engineering and Informatics 5-7 August 2009, Selangor, Malaysia.

[10]. Daniel J. Dailey, Member, IEEE, F. W. Cathey, and Suree Pumrin, "An Algorithm to Estimate Mean Traffic Speed Using Uncalibrated Cameras", IEEE Transactions on intelligent transportation systems, Vol.1, No. 2, June 2000.

[11]. Jesse Scott , Michael A. Pusateri, Ph. D. , Duane Cornish "Kalman Filter Based Video Background Estimation".