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Comparative Analysis of Vehicle Tracking System Using Optical Flow and Kalman Filter

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Abstract-Vehicle tracking has a wide variety of applications. The image resolution of the video available from most traffic camera system is low. In many cases for tracking multi object, distinguishing them from another isn't easy because of their similarity. In this paper we describe a method, for tracking multiple objects, where the objects are vehicles. The number of vehicles is unknown and varies. We detect all moving objects, and for tracking of vehicle we use the kalman filter and color feature and distance of it from one frame to the next. So the method can distinguish and tracking all vehicles individually. The proposed algorithm can be applied to multiple moving objects. The more than one-vehicle surveillance approach developed in this thesis, situated on integrating modules, provides a novel technique for automobile monitoring. In addition, the system makes use of minimal a priori knowledge about auto location, size, kind, numbers, and pathways.

Keywords :-Kalman filter, occlusion, active contour, Ad-Hoc Network

I. INTRODUCTION

There are a number of traffic monitoring technologies being used. Traffic cameras provide a more flexible way of monitoring traffic. These cameras not only can be used in simple tasks like counting cars, they also have the potential to be used in more complex applications like tracking. The process applied on this work capabilities well underneath more than a few digital camera views, historical past muddle, car viewpoints, road forms, scale alterations, picture noise, picture resolutions, and lighting fixtures stipulations. The moving object monitoring in video photos [1] has attracted a nice deal of interest in laptop vision. For object cognizance, navigation programs and surveillance techniques [10],

We advocate a novel algorithm for object monitoring in video photographs, situated on snapshot segmentation and pattern matching [1]. With the photo segmentation, we are able to notice all objects in pictures no matter whether they're moving or now not. Making use of snapshot segmentation results of successive frames, we exploit sample matching in a simple characteristic area for monitoring of the objects. For that reason, the proposed algorithm can be utilized to more than one moving and nonetheless objects even in the case of a relocating diagram.

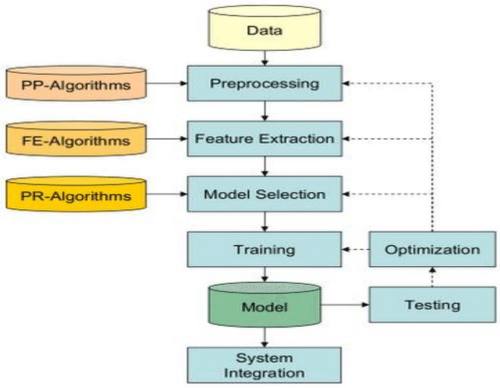


Figure 1.1Block diagram of pattern recognition algorithm

1.1 Object Detection and Tracking

Video surveillance is an active research topic in computer vision that tries to detect, recognize and track objects over a sequence of images and it also makes an attempt to understand and describe object behavior by replacing the aging old traditional method of monitoring cameras by human operators. Object detection and tracking are important and challenging tasks in many computer vision applications such as surveillance, vehicle navigation and autonomous robot navigation. Object detection involves locating objects in the frame of a video sequence. Every tracking method requires an object detection mechanism either in every frame or when the object first appears in the video. Object tracking is the process of locating an object or multiple objects over time using a camera. The high powered computers, the availability of high quality and inexpensive video cameras and the increasing need for automated video analysis has generated a great deal of interest in object tracking algorithms.

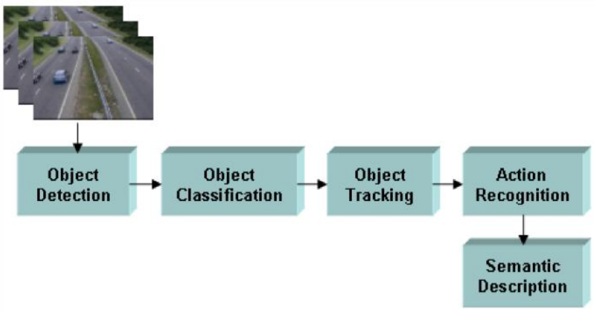


Figure 1.2: Analysis of detection and tracking Approach

1.2 Object Detection and Tracking Overview

The overview of our real time video object detection, classification and tracking system is shown in Figure 3.1. The proposed system is able to distinguish transitory and stopped foreground objects from static background objects in dynamic scenes; detect and distinguish left and removed objects; classify detected objects into different groups such as human, human group and vehicle; track objects and generate trajectory information even in multi-occlusion cases and detect fire in video imagery. In this and following chapters we describe the computational models employed in our approach to reach the goals specified above.

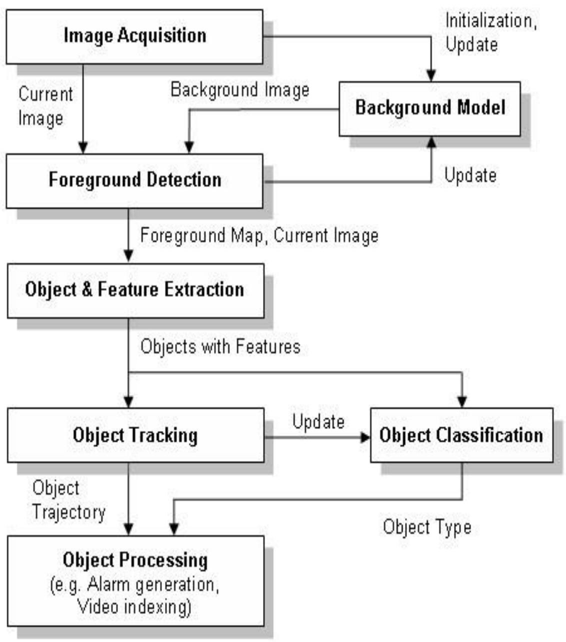


Figure 1.3: Analysis of Object Detection

II. LITERATURE REVIEW

[1]ShotaKanaki et al [2016] present cooperative moving object tracking with multiple mobile sensor nodes, each equipped with a multilayer laser scanner. Moving objects in the laser-scanned images are detected by a binarized occupancy grid method. The sensor nodes send the information of the detected moving objects to a central server, which estimates the size, position, and velocity of those objects using a Bayesian filter and feeds the estimates back to the sensor nodes.

[2] Wang Xiaojun et al [2015]Moving target detection and tracking algorithm research content is very broad and complex applications, without and different target features directly affects the detection of selected tracking algorithm. So far still does not exist a universal algorithm for perfect can be suitable for various applications, so the detection and tracking of moving targets is still a valuable research subject of.

[3] Jong-Min Jeong et al [2014] Visual target tracking is one of the major felds in computer vision system. Object tracking has many practical applications such as automated surveillance system, military guidance, trafc management system, fault detection system, artifcial intelligence and robot vision system. But it is diffcult to track objects with image sensor. Especially, multiple objects tacking is harder than single object tracking. This paper proposes multiple objects tracking algorithm based on the Kalmanflter. Our algorithm uses the Kalmanflter as many as the number of moving objects in the image fame. If many moving objects exist in the image, however, we obtain multiple measurements. In this paper, we proposed the Kalmanflter based multiple objects tracking algorithm.

[4] EmadeldeenNoureldaim et al [2013] In this article we propose to combine an integrated method, the PCA-GMM method that generates a relatively improved segmentation outcome as compared to conventional GMM with Kalman Filtering (KF). The combined new method the PCA-GMM-KF attempts tracking multiple moving objects; the size and position of the objects along the sequence of their images in dynamic scenes.

2.1 Contour Based Object Tracking

[1]Xu and Ahuja [6] proposed a contour based object monitoring algorithm to track object contours in video sequences. Of their algorithm, they segmented the active contour utilising the graph-cut picture segmentation process. The resulting contour of the prior frame is taken as initialization in each frame. New object contour is found out with the support of depth know-how of present frame and difference of present body and the prior frame.

[2]Dokladal et al.[7] the proposed strategy is lively contour established object tracking. For the driver's-face tracking situation they used the combo of function-weighted gradient and contours of the item. Within the segmentation step they computed the gradient of an snapshot. They proposed a gradient-situated enchantment discipline for object tracking

[3] Chen[8] items an active contour situated object tracking with the aid of Neural Fuzzy community.Contour-based model is used to extract object's characteristic vector. For training and recognizing moving objects their strategy makes use of the self-constructing neuralfuzzy inference community. In this paper, they've taken the histograms of the silhouette of human body in horizontal and vertical projection after which transform it with the aid of Discrete Fourier develop into (DFT).

[4] Zhou et al.[10] uses the integration of color characteristic and contour know-how within the particle

filter established multi-speculation tracking algorithm. For the contour detection they have used sobel operator and the shape similarity is evaluated between the watching function and the pattern position by using corresponding aspects matching in the two contour photographs.

III. PROBLEM STATEMENT

In this thesis our aim is to improve the performance of object detection and tracking by contributing originally to two components (a) motion segmentation (b) object tracking.

Automated tracking of objects can be used by many interesting applications. An accurate and efficient tracking capability at the heart of such a system is essential for building higher level vision-based intelligence. Tracking is not a trivial task given the non-deterministic nature of the subjects, their motion, and the image capture process itself. The objective of video tracking is to associate target objects in consecutive video frames. We have to detect and track the object moving independently to the background. In this there are four situations to be considered in the account:

- Single camera and single object,
- Single camera and multiple objects,
- Multiple cameras and single object,
- Multiple cameras and multiple objects.

3.1 Image segmentation and Pattern matching

The frames extracted from the video are segmented first, features of each object in the segmented image are extracted, pattern matching is done on the consecutive frames having the desired features in the hand, the motion vectors are calculated and mask is moved accordingly.

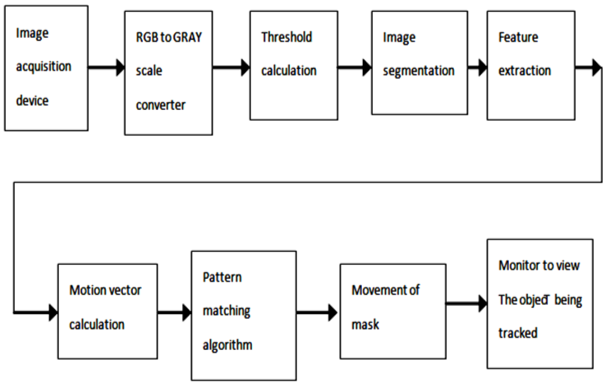


Fig.3.1 Block diagram of Proposed Method of Object Tracking

3.2 Feature Extraction

Feature extraction is a phase of the recognition process in which the objects are measured. A measurement is the value of some quantifiable property of an object. A feature is a function of one or more measurements, computed so that it quantifies some significant characteristic of the object. This process produces a set of features that, taken together, comprise the feature vector. There are various ways to generate features from the raw data set. A number of transformations can be used to generate features. The basic idea is to transform a given set of measurements to a new set of features. Transformation of features can lead to a strong reduction of information as compared with the original input data. So for most of the classification a relative small number of features is sufficient for correct recognition. Obviously feature reduction is a sensitive procedure since if the reduction is done incorrectly the whole recognition system may fail or not present the desired results.

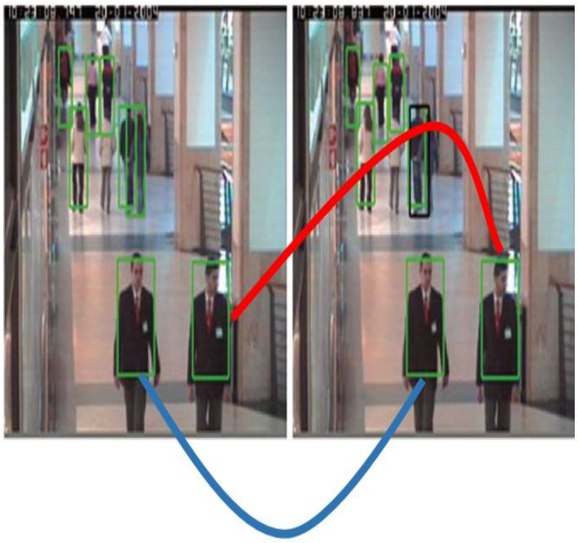


Fig.3.2 moving object detection

3.3 Pattern Recognition

In pattern recognition and in image processing, Feature extraction is a special form of dimensionality reduction. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data, but not much information) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called features extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input.

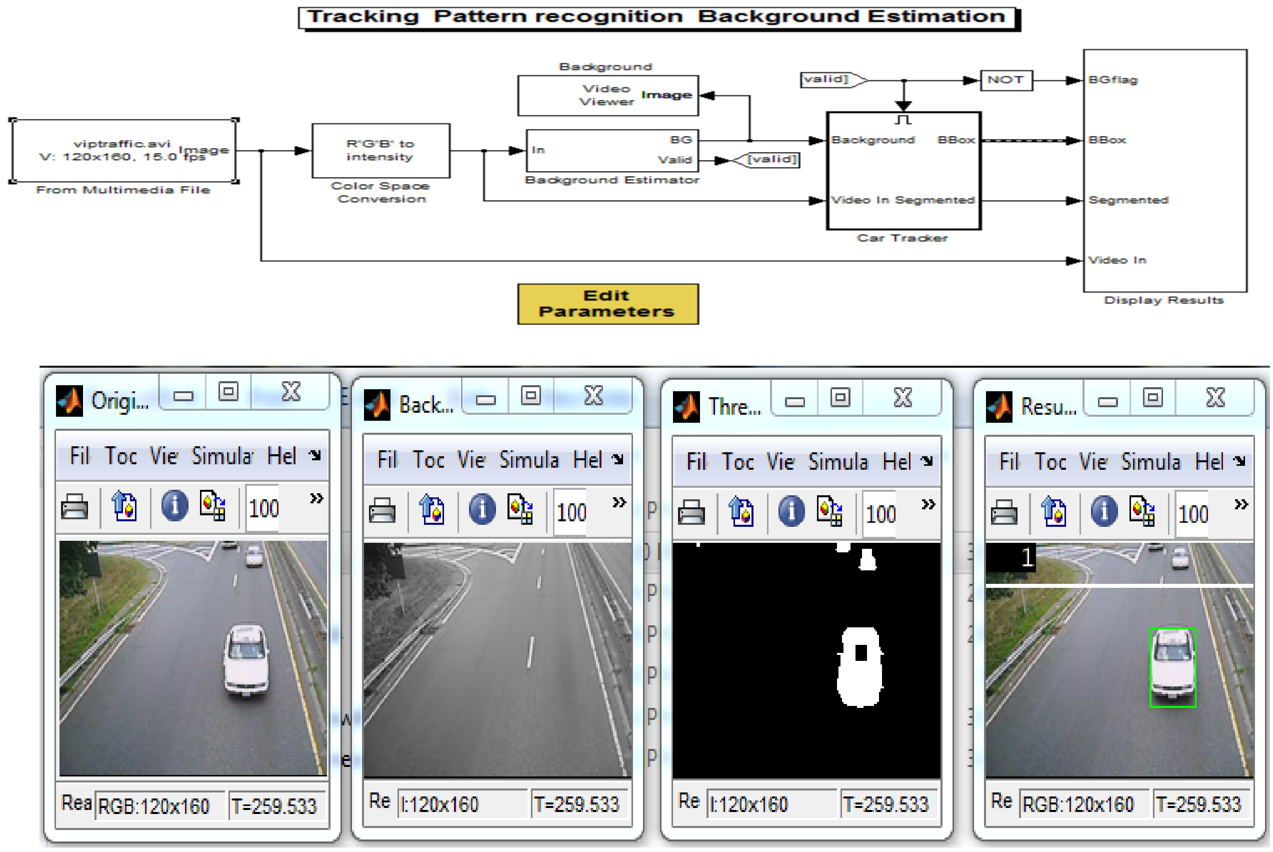


Figure 3.3 Object Tracking Using Optical Flow

Optical flow or optic flow is the pattern of apparent motion of objects, surfaces, and edges in a visual scene caused by the relative motion between an observer (an eye or a camera) and the scene. It is the displacement field for each of the pixels in an image sequence. It is the distribution of the apparent velocities of objects in an image. By estimating optical flow between video frames, one can measure the velocities of objects in the video. In general, moving objects that are closer to the camera will display more apparent motion than distant objects that are moving at the same speed. Optical flow estimation is used in computer vision to characterize and quantify the motion of objects in a video stream, often for motion-based object detection and tracking systems.

Improved optical flow algorithm for Occlusion handling

Input V Video file

1. Extract horizontal and vertical components of optical flow with varied frame difference delay.

For linear function:-$_L$5 + $_M$N + = 0 (15)

Where L, M and are the spatiotemporal image brightness derivatives x is the horizontal optical flow and yis the vertical optical flow. (x,y,∇t) where ,∇t is frame difference delay.

2. µ compute mean for each frame // Find the mean for each frame
3. V_{med} median () // Apply median filter for removal of noise
4. Apply morphological close and erosion operation on each frame
5. **For each** frame$_i$∈ Video
6. Estimate optical flow. The optical flow vectors are stored as complex numbers. Compute their magnitude squared which will later be used for thresholding.
7.

$$E = \iint (A_i x + A_j y + A\ )^2 didj + \propto \iint \{(\frac{\partial x}{\partial i})^2 + (\frac{\partial x}{\partial j})^2 + (\frac{\partial y}{\partial i})^2 + (\frac{\partial y}{\partial j})^2\} didj \quad (16)$$

In this equation,

$\frac{\partial x}{\partial i}$ and $\frac{\partial x}{\partial j}$ are the spatial derivatives of the optical velocity component x, and α scales the global smoothness term. E is estimation of optical flow.

8. Compute the velocity threshold from the matrix of complex velocities.

$$x_{i,j}^{m+1} = x_{i,j}^{-m} - \frac{A_i(A_i x_{i,j}^{-m} + A_j y_{i,j}^{-m} + A_k)}{\alpha^2 + A_i^2 + A_j^2} \quad (17)$$

$$y_{i,j}^{m+1} = y_{i,j}^{-m} - \frac{A_j(A_i x_{i,j}^{-m} + A_j y_{i,j}^{-m} + A_k)}{\alpha^2 + A_i^2 + A_j^2} \quad (18)$$

In this equation, $[x_{i,j}^{m}, y_{i,j}^{m}]$ is the velocity estimate for the pixel at (*x*, *y*), and $[x_{i,j}^{-m}, y_{i,j}^{-m}]$ is the neighbourhood average of $[x_{i,j}^{m}, y_{i,j}^{m}]$. For *m=0*, the initial velocity is 0.

9. If $frame_i \leq h$// h Threshold the image.

End for

10. $Thin\_frame_i$=morph_thin ($frame_i$) //Apply thinning to the Objects to fill the holes in the blobs.

11. Compute area function_area ($frame_i$) // Estimate the area and bounding box of the blobs.

$$6i=(5_{]jA}-5_{]Lk})*(N_{]jA}-N_{]Lk}) \quad (19)$$

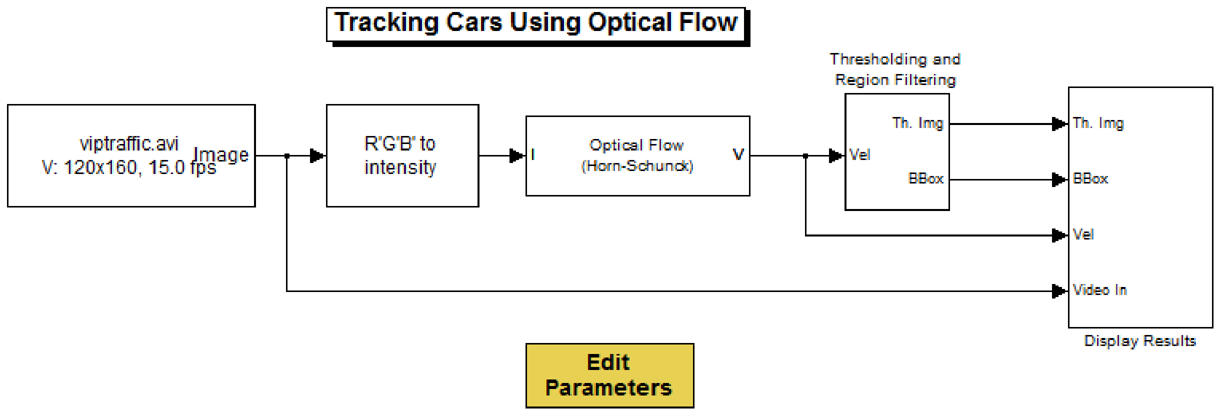
12. Draw bounding boxes around the tracked objects.

13. Calculate and draw the motion vectors.

$$S_A = 5' - 5 = m_A(,5,N), S_B = N' - N = m_B(,5,N) \quad (20)$$

Where x, y-location in previous image, x', y' - location in current image a, b- motion vector coefficient and S_A, S_B- displacement

14. Display results with tracked videos.



Hence tracking of objects from a given video dataset has become efficient as we are able to track more number of objects as well as occlusion can also be handled during the tracking as shown in Fig.3.4.

Fig. 3.4 Multiple object tracking using optical flow under occlusion

IV. PERFORMANCE ANALYSIS

We observe the performance of the algorithms under various conditions on MIT Traffic video dataset as shown in Table 1. We observed that kalman filter algorithm is good for detecting moving object; moderate for lighting changes, roped frames, similar background shapes, similar background colours but it is bad for dim light video dataset, low resolution videos, stationary object and change in velocity. Whereas optical flow algorithm is good for detecting moving object, similar background shapes, similar background colours and change in velocity; moderate for dim, bright video datasets and dropped frames but it performs bad for low resolution video and lighting changes. Improved optical flow algorithm is moderate with dim, bright, dropped frames and lighting changes. It is bad only for stationary objects but good for moving objects with similar background shapes and colours and also good if there is change in velocity.

Table -1 Performance Analysis of Kalman, Optical Flow and Improved Optical Flow Tracking

Algorithm	Background	Improved optical flow
dim	Ok	Ok
bright	Ok	Ok
Lighting changes	bad	Ok
Moving object	good	good
Stationary object	bad	bad
Dropped frames	Ok	Ok
Low resolution	bad	Ok
similar back ground shapes	good	good
Similar back ground colours	good	good
Change in Velocity	good	good

Accuracy of Kalman, Optical Flow and Improved Optical Flow Tracking

Algorithm	Accuracy	Time required to track objects
background	85%	3-5 minutes
Optical Flow	90%	2-3 minutes
Improved optical flow	96%	1-2 minutes

Table 6: An overview of evaluation metrics for MOT. The up arrow (resp. down arrow) indicates that the performance is better if the quantity is greater (resp. smaller)

Type	Concern	Metric	Description	Note
Detection	Accuracy	Recall	correctly matched detections over ground-truth detections	↑
		Precision	correctly matched detections over result detections	↑
		FAF/FPPI	number of false alarms averaged over a sequence	↓
		MODA	take the miss detection, false positive rate into account	↑
	Precision	MODP	the overlap between true positives and ground truth	↑
Tracking	Accuracy	MOTA	take the false negative, false positive and mismatch rate into account	↑
		IDS	the number of times that a tracked trajectory changes its matched ground-truth identity	↓
	Precision	MOTP	overlap between the estimated positions and the ground truth averaged over the matches	↑
		TDE	difference between the ground-truth annotation and the tracking result	↓
	Completeness	MT	percentage of ground-truth trajectories which are covered by tracker output for more than 80% in length	↑
		ML	percentage of ground-truth trajectories which are covered by tracker output for less than 20% in length	↓
		PT	1.0 - MT - ML	-
		FM	the number of times that a ground-truth trajectory is interrupted in tracking result	↓
	Robustness	RS	the ratio of tracks which are correctly recovered from short occlusion	↑
		RL	the ratio of tracks which are correctly recovered from long occlusion	↑

V. FUTURE WORK

The relative simplicity of this tracking algorithm promises that an FPGA implementation is possible and already sufficient for real time applications with a few moving objects. Thus, VLSI implementation of the algorithm is possible by using our developed architectures for image segmentation and a fully parallel associative memory with high-speed minimum Manhattan distance search, both of which have been already realized as VLSI circuits.

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