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IMPLEMENTATION OF OBJECT TRACKING USING SINGLE CAMERA BY KALMAN FILTER

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Abstract — *Basically object detection and object tracking are two important and challenging aspects in many computer vision applications like surveillance system, vehicle navigation, autonomous robot navigation, compression of video etc. Object detection is first low level important task for any video surveillance application. To detection of moving object is a challenging task. Tracking is required in higher level applications that required the location and shape of object. Object detection and tracking especially for human and vehicle is currently most active research topic. The work described over here is focused on tracking a randomly moving object chosen by a user using Kalman filter. For simplicity, a video sequence with just one object within has been selected. In this thesis, proposed methodology has been presented. In image processing, there are many algorithms which can be used for object detection and as well as tracking of object. But in all this method there are many problems in tracking while object is smooth so there is need to use Kalman filter.*

Keywords-*Object tracking, kalman filter*

I. INTRODUCTION

In a computer vision Video surveillance is an active research topic, and we identify and track objects over a sequence of images that tries to find out with the help of, identify and track items on the order of the images and also by human operators to understand and monitor the aging of the camera by replacing the old traditional method of making an attempt to describe the object's behavior. Basically detection and object tracking surveillance system, vehicle navigation, autonomous robot navigation, video, etc. Many computer vision applications such as compression are two important and challenging aspects. It aims to place video file or moving objects are surveillance cameras. Indeed videos sequences of images, so the continuity of its content every human eyes can catch enough frequency so that the display is very fast, is called a frame.

To detection of moving object is a challenging task. Object detection involves locating objects in the frame of a video sequence. Tracking is required in higher level applications that required the location and shape of object. Each tracking method appears to be the first video where every frame or objects while the object detection method is required.

In Object Detection and Tracking we have to detect the target object and track that object in consecutive frames of a video file. Interesting moving objects detection, frame, frame such as object tracking, and object analysis is to recognize their behavior: There are three key steps of the video analysis. Therefore, the use of object tracking, motion-based recognition is pertinent in the works. Automatic object detection, object tracking, and count the number of objects in a variety of home, business in a wide range of difficult tasks, such as security, surveillance, access point management, urban planning, traffic control, as industrial applications.

1.1BASIC OF OBJECT TRACKING:

Object Tracking Computer Vision is an important research topic. he rapid increase in the number of great-powered computers, high-quality and high precision, and cheap video camera. As a result, (person, face, hands, glass, and cars), tracking substance use automobile driver assistance, vehicle navigation, robotics, human-computer interaction, video surveillance, biometric, Video Games, and industrial automation and security functions[25]. Moving objects detection, frame, frame such as object tracking, and object analysis is to recognize their behavior: There are three key steps of the video analysis.

1.2CHALLANGES OF OBJECT DETECTION AND TRACKING:

Fundamentally Object tracking, video sequence includes successive frames of a particular region of the projections. Object can be rather complex structures and subsequent video frames on the shape, size, location and orientation may change, especially since the investigation properly, things can be a challenging task. Different algorithm

and technique have been introduced in decades and track object in particular video and each algorithm. A better and efficient algorithm tracker application is accurate to the time frame in which this type of target (object slow movement) should be able to reduce.

In object tracking the important challenge that has to consider while the operating a video tracker are when the background is appear which is similar to interested object or another object which are present in the scene. This phenomenon is called as clutter.

The other challenges except from cluttering may difficulty to detect interested object by the appearance of the that object itself in the frame plane due to factors which are described as follows:

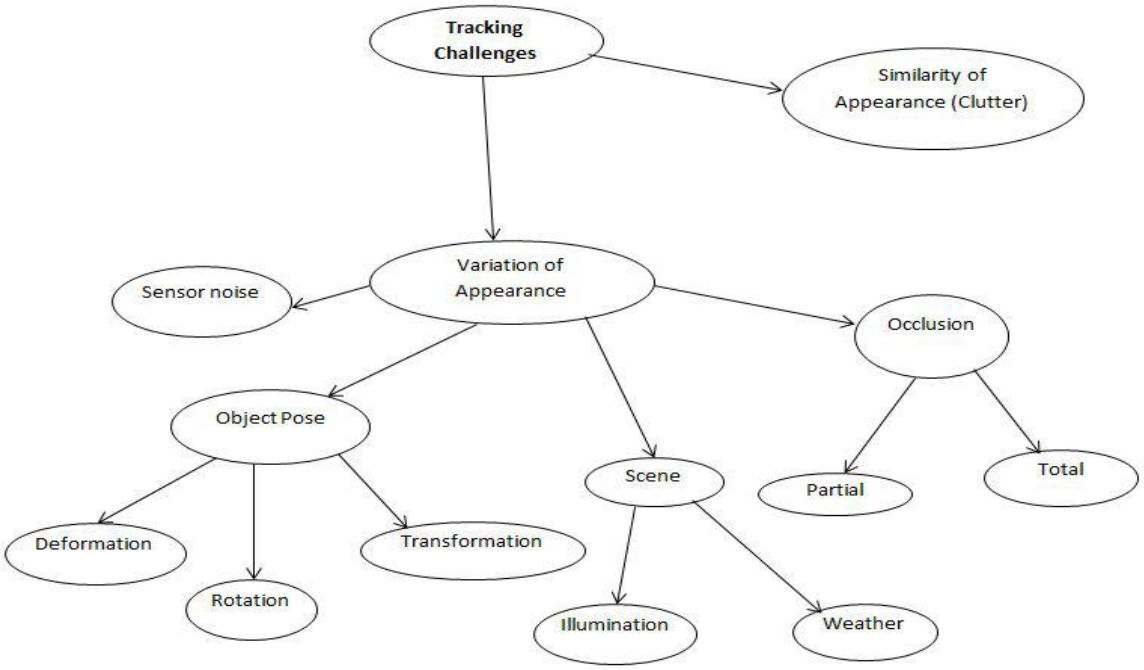


Figure 1.1:- Main challenging task in video tracking [3]

1.3 OBJECT DETECTION AND TRACKING PIPELINE:

To overcome the different challenges issue as discussed in previous section there are following main component of object detection and tracking

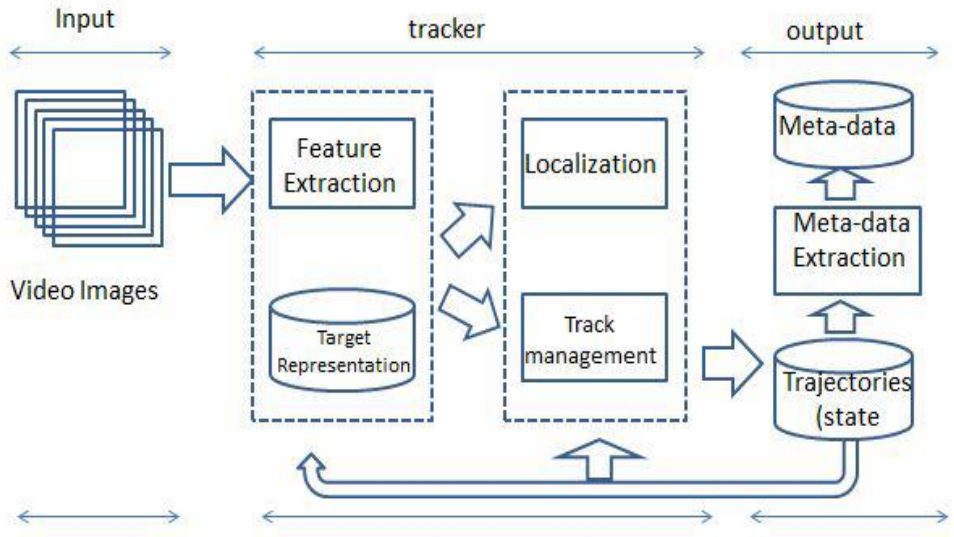


Figure 1.2:- Basic component of object tracking algorithm [2]

1.3.1 Feature extraction

Any object tracking algorithm can be analyzed by the quality of information that can be extracted from video frames or an image. To get more exploit information from image, we use image formation technique to extract feature which are more important, significant to identify interested object uniquely without any disambiguation.

- From the image background in the scene and
- From many another objects which are present in the scene

For any tracking algorithm extracting feature is the important step which is allowing us to highlight the information of the interested object from the video frames or target image plane. Extracted feature can be of three types:

- . Low level extraction, e.g., motion, color, gradient
- . Mid level extraction, e.g., edge, corner, interest point, region
- . High level extraction, e.g., centroid, area, orientation, whole object

1.3.2. Target representation

The model that can be used by any tracking algorithm to represent the interested object is known as target representation. That model includes the information of interested object about the shape, size and appearance in an image. The model depends on the interested object and tracking algorithm that are used. There are different ways to model an interested object:-

- It may define priori of interested object
- It may snapshot of interested object
- It may be decided by training sample
- There are two ways of target representation
- Shape representation, e.g., centroid, rectangle, ellipse, rigid model, contours or point distribution model
- Appearance representation, e.g., template, histogram

1.3.3 Localization

Localization, depending on the initial position we have, over time, describes how to localize an object. After initialization step of the localization of a video tracker recursively extracted feature of video frames and the previous state estimate X1 Xk's estimate: Xk. Methods can be classified into two main classes

- Single hypothesis localization (SHL)
- Multiple hypothesis localization (MHL)

1.3.4 Track management

Usually presented tracking algorithms to estimate the status of video frame plane depends on the object of interest. In a particular application, it can rely on one of those initiated by the user when creating a tracker is acceptable, which is an operational condition. The interest of a number of objects in real time in a variety of application, Tracker automatic initialization and automatic termination of the need to use the ability.

1.3.5 Trajectory

It is path that moving objects follow the space as a function of time. The path geometry over time either as the position of the object can be described mathematically. It is the object of interest, so that continuous information about the actual path of the target in the frame store. We change the direction and speed of the target is what will get all the information about the target object.

II. OBJECTIVE

Object tracking is becomes very crucial topic for the computer vision community. Here objective of this project is to detect and track moving object from the different video stream. Overhere we track and detect multiple objects from video stream using background substraction method and tracking of multiple object is done by kalman filter and also implement this algorithm in real time.

III. LITERATURE REVIEW

Object tracking is one of the most important techniques in digital image processing. Considering the weakness and shortage of traditional moving target tracking method, this paper designed and realized a simple and effective object tracking method. This paper utilized a kind of adaptive background subtraction and improved camshift algorithm to realize the moving target detection and tracking. Through the experimental results, we know that the algorithm can track the target efficiently and with high robustness. But if the conditions become worse, further improvement is needed. [1].

In another paper discuss about background subtraction and mean shift tracking are used to track vehicles. Background model Firstly, secondary selected strategy is used to construct background model. Then vehicle tracking

objects are built at the trigger area of detection by the background subtraction. Finally, the mean shift algorithm is utilized to track vehicles. The new algorithm designed in this paper .It can reconstruct quickly the accurate background from the crowd video frames. Using background subtraction can eliminate the interference of background on the color probability density of target in mean shift algorithm. The whole algorithm achieves the real-time tracking in complicated situation in a high accuracy. Vehicle detection in the proposed system is robust, improvement is needed to help detect vehicles at various weather conditions. That will be the next challenge in the future work. [2]

Object tracking and activity analysis is important to the visual surveillance. Handling multiple visual target tracking occlusion is a major issue. Here we consider the characteristics of the target color piece with a Kalman filter based on weighted average proposed shift. Discrete wavelet transform is used to automatically find the target. Fragmented weighted average shift output is updated with the help of the Kalman filter. Videos proposed tracking algorithm in different situations on the many challenging tests and has been compared with Mean shift method. Handed approach to the reduction and limitations of the proposed method is not adaptive. Release parameters are not considered. We create the future mechanism for more effective and robust plan to address this issue. [3]

IV. PROPOSED SYSTEM

Here this is the block diagram of proposed system. here we used background substraction methodology for object detection and object tracking using kalman filter. We can detect the object with the help of preprocessing. after preprocessing steps object is detected.

4.1 Preprocessing:

Mainly object detection method consists of two main steps. A first step Gray scaling, including smoothing preprocessing step, and so on and reduce the image resolution. The second step is the substance contained in the filtering to remove image noise. Such as dilation and erosion morphology filter filters the filtering is done by the application. And finally filtered image are connected component labeling. The first step in the preprocessing phase of the moving object detection process image data captured using a video camera. In order to reduce processing time, a grayscale image instead of a color image is used on the entire process. Only the RGB image to grayscale image has three color channels when a color channel that contains 8 bits. Image Smoothing To achieve high accuracy for detecting moving objects in an image from the input image to reduce noise is performed.

4.2 Block Diagram of Proposed System:

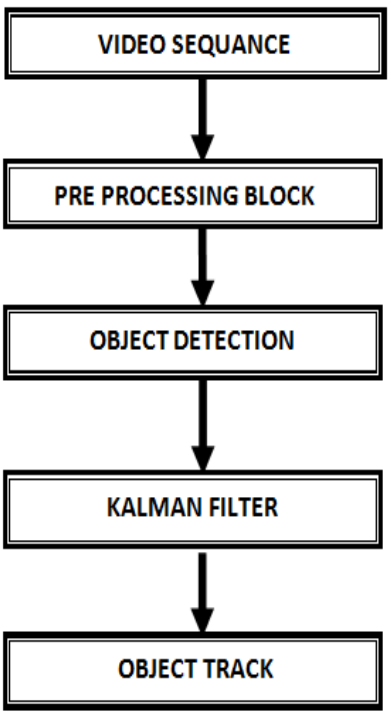


Figure 4.1:- Block diagram of proposed system

4.2 Background Subtraction:

The video sequence having background and foreground part. We are only interested in the motion part so our aim is to remove the background. How background is subtracted is shown in result. Background subtraction of certain items in the foreground of the scene is the process of extracting a computational vision. The foreground object processing as well as to act under consideration can provide important information which helps to reduce the amount of data that can be described as an object of attention. Often, the foreground object can be thought of as a scene in a consistent moving object.

We have a person walking in front of moving leaves, as relevant here must emphasize the word, Although the pace of the person associated with them due to its repetitive behavior leaves are considered background, while the foreground object is created. It is considered to be the background in some cases, also forms the basis of the distance of the moving object, eg Remove the background of a person, while a scene one person close to the camera, Person away its small size and lack of information due to which it provides is omitted, when the case is considered to be the closest person in the foreground. Identify moving objects in video sequence of many computer vision applications is fundamental and complex task. A common approach is distinguished background model that identifies moving objects from the portion of the video frame; the background subtraction is to perform. Background subtraction surveillance system for programs of interest to a scene out of a class of techniques for segmenting.

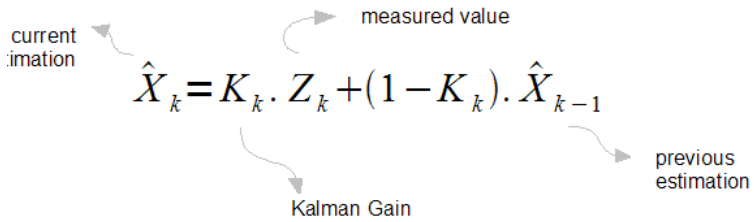
No background subtraction algorithm development has many challenges. First, it must be robust against light changes. Second, it objects caught by moving non-stationary background objects (e.g. rain, snow) as well as finding should avoid shadows. A good background model also reacts quickly to changes in the background and the background of such a site, the chair should adapt itself to accommodate changes occurring. It's also a good detection rates and real-time should be in the foreground to the background subtraction processing time should be. A real-time program works much work that has been made toward obtaining the best possible background model.

4.3 Kalman Filter:

On May 19.1930 Emil Rudolf Kalman, Budapest, Hungary was born. In 1958, the year he first had the idea for the Kalman filter. The kalman filter is recursive predictive filter that is based on the use of state space technique and recursive algorithams. It estimates the state of dynamic system. This dynamic system can be distributed by some noise. The Kalman filter uses state-related but are disturbed that the estimated size of the state to improve.
The Kalman filter consists of two measures:

1. The predict (Predicting the new state and its uncertainty)
2. The correction (Correcting with the new measurement)

Figure 4.2:- Predict - Correct



In the first step the state is predicted with the dynamic model. In the second step is it corrected with the observation model, so that the error covariance of the estimator is minimized. In this it is an optimal estimator. The Kalman filter system even if an exact form, the system dynamic state estimation. Filter the past, the current estimate that supports a very powerful sense

The Kalman filter estimates a process by using a prediction and then an actual measurement of a process. The filter estimation noise is then minimized to get a better prediction in a next state of process. The Kalman filter equations can be categorized into two groups: time update equations and measurement update equations. The time update equations are responsible for projecting forward (in time) the current state and the prior error covariance estimation matrix for the next time step.

The measurement update equations are responsible for the feedback i.e. minimizing the error between an object actual and predicted position. The time update equations can also be thought of as predictor equations, while the measurement update equations can be thought of as corrector equations. The whole process of a Kalman filter is explained in the algorithm.

The Kalman filter algorithm starts with parameters initialization for each object. The matrices $X0$,, P, Q, R, A and H are set to their initial predefined value. The first time, object x and y position estimation and prior error covariance matrix also calculated in initialization. In fact, position estimation and the prior error covariance matrix calculation is required in the initialization process.

Input: Take object current position and velocity
Output: Predict object position for next frame

Initialization: **do**
Initialize matrices $X_{0,}$ P, Q, R, A and H to predefined values
$\hat{X}_t = A\hat{X}_{t-1}$
$P_t = AP_{t-1}A^T + Q$
end
foreach *frame time t* **do**
  foreach *Kalman filter measurement update equation* **do**
    $K_t = P_t H(HP_t H + R)^{-1}$;
    $\hat{X}_t = \hat{X}_t + K_t(Z_t - H_k\hat{X}_t)$;
    $P_t = \bar{P}_t - K_t H\bar{P}_t$
  end
  foreach *Kalman filter process update and prediction equations* **do**
    $\hat{X}_{t+1} = A\hat{X}_t$;
    $\bar{P}_t = AP_{t-1}A^T + Q$
  end
end

Figure 4.3:- Kalman filter algorithm

After the initialization, the algorithm enters into the second step, which is measurement correction and update. In the last step of the algorithm, the filter process is updated and the object position is predicted for the next frame. $\hat{}\bar{}Xt+1$ is the estimated/predicted state of the process. $\hat{}Xt$ is the corrected state of the process. Pt is posterior error covariance matrix. $\bar{}Pt = E[\ \hat{}\ et\ \hat{}\ eT\ t\ ]$ is the prior error covariance matrix between estimated and actual state of the process. $Q = E[Wt\ WT\ t\ ]$ is the covariance matrix of noise process and $R = E[Ut\ UT\ t\ ]$ is the covariance matrix of the measurement error.

V. RESULT AND DISCUSSION

In the current project work MATLAB version 13 is used as a software tool for developing different modules. MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. MATLAB product is used to solve technical computing problems faster than with traditional programming languages, such as C, C++, and FORTRAN.

5.1 Motion-Based single and Multiple Object Tracking

Motion detection and tracking of moving objects based activity recognition, traffic monitoring, and automotive safety are important components of many computer vision applications. Motion-based object tracking problem can be divided into two parts:

- Detecting moving objects in each frame
- Associating the detections corresponding to the same object over time

Gaussian mixture models based on the detection of moving objects using background subtraction algorithm. Morphological operations resulting from the noise mask is applied to the foreground. Finally, blob analysis detects connected group moving objects which are likely to correspond to the pixels.

Association of detections for the same substance is based on the same motion. Each track motion is estimated by a Kalman filter. The filter in each frame of the forecast track, and each being assigned to each track to determine the chances of detection are used. Other detections and the track can remain Unassigned, any frame, some detection, tracks can be assigned. The assigned track is updated using the corresponding detections. The Unassigned invisible track is marked. Unassigned begins a search for a new track. How many things in motion detection are tracked using Kalman filter. On The first video frame of system objects are created to read. Then the Kalman filter is used for tracking objects based on motion. The total number of the frame in which the track is detected. Here it based motion track how many items are shown. The algorithm involves two steps:

Step 1: The distance to each track using the method to calculate the cost of each search assign. Consider the value of the predicted track of the Euclidean distance between the centroid and centroid investigation takes. It is maintained by a Kalman filter, which includes a confident prediction.

Step 2: Tracks assigned to work detections using the value represented by the matrix assignment solve the problem. The task is to track the cost matrix and does not charge any assigning detections. Cost assignment Kalman filter to search a track spacing value returned by the method depends on a range of values. The value must be tuned experimentally. Setting it too low increases the likelihood of creating a new track, and tracks can result in splitting. It's very high, regardless of the single-track series of different moving objects may result in a setting.

5.2 RESULT OF PROPOSED METHOD

- In the result of single or multiple object tracking in the output there are six videos are found.
  1. Original Video 2.Foreground Extracted 3.filtered 4.object detection 5.kalman filter 6. Result. In the result of kalman filter.

❖ **RESULTS FOR VIDEO 1**

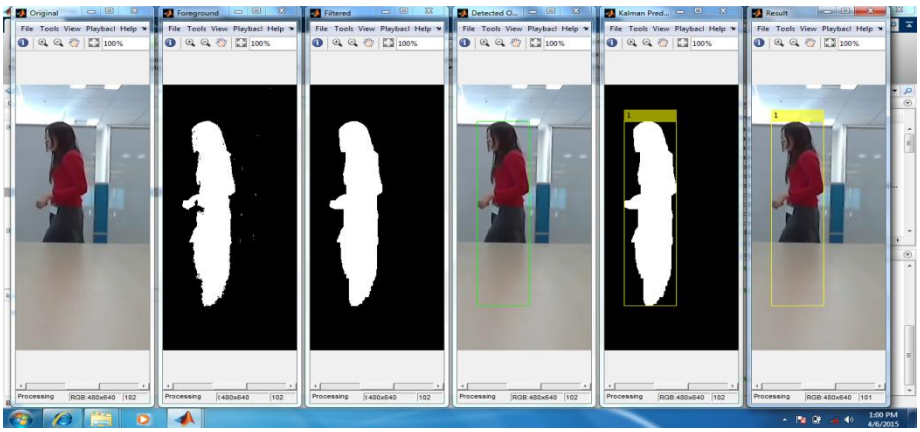


Figure 5.1:- Single object tracking by kalman filter (video 1)

❖ **RESULTS FOR VIDEO**

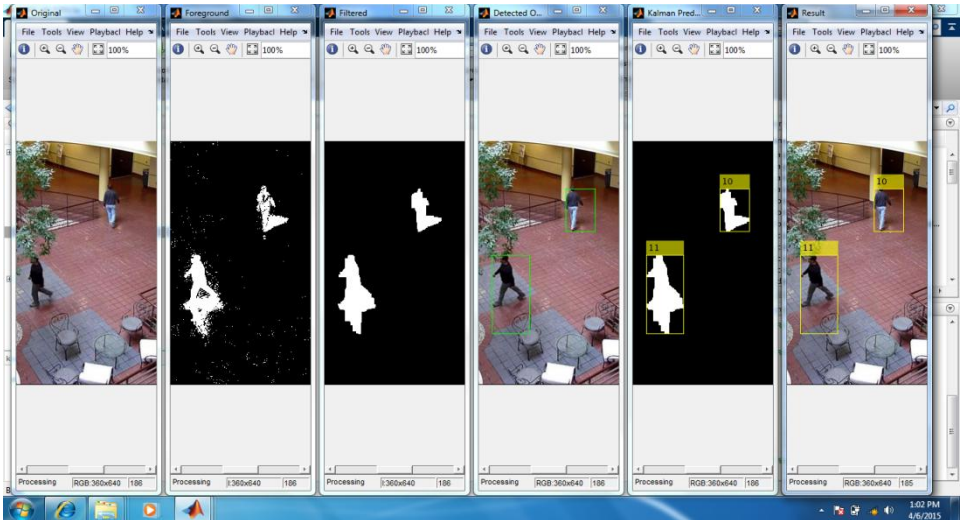


Figure 5.2:- Multiple object tracking by kalman filter (video 2)

❖ **RESULTS FOR VIDEO 3**

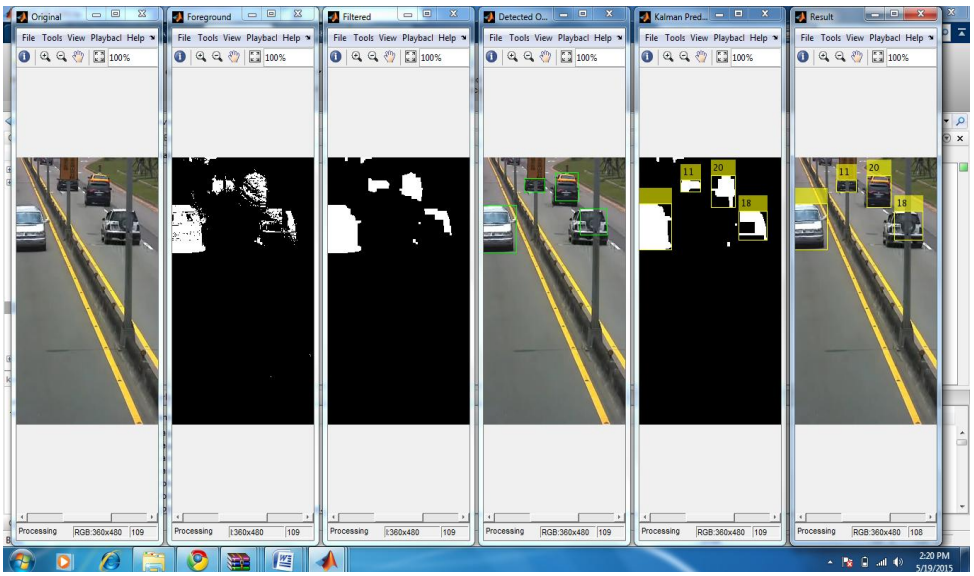


Figure 5.3:- Multiple object tracking by kalman filter (video 3)

❖ **RESULTS FOR VIDEO 4**

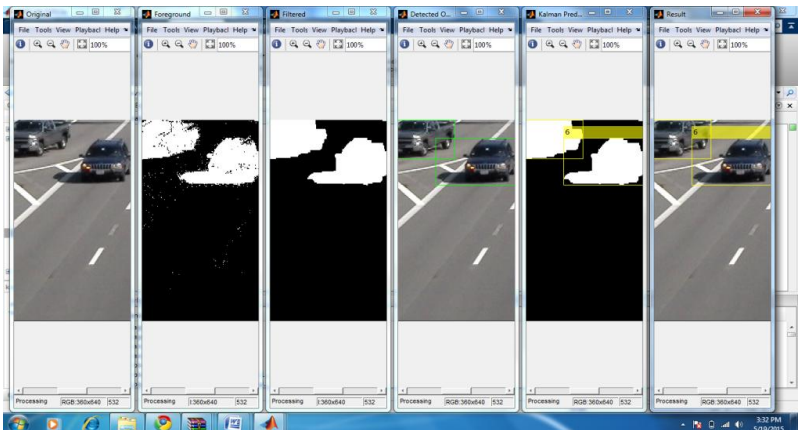


Figure 5.4:- Multiple object tracking by kalman filter (video 4)

5.3 RESULT OF EXISTING METHOD

- In the result of Optical Flow method four videos are found.
  1. Original video 2. Motion vectored 3.thresholded 4.human detected

❖ **RESULTS FOR VIDEO 1**

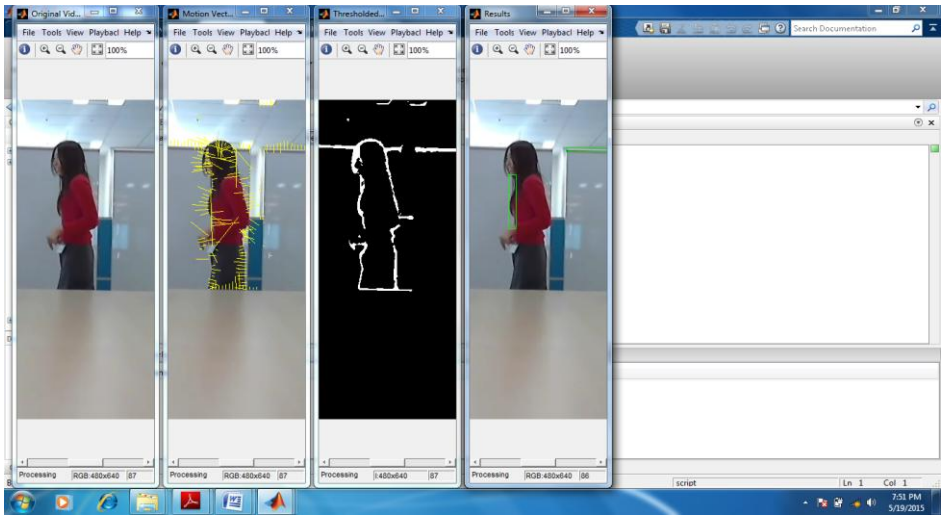


Figure 5.5:- Single object tracking by optical flow (video 1)

❖ **RESULTS FOR VIDEO 2**

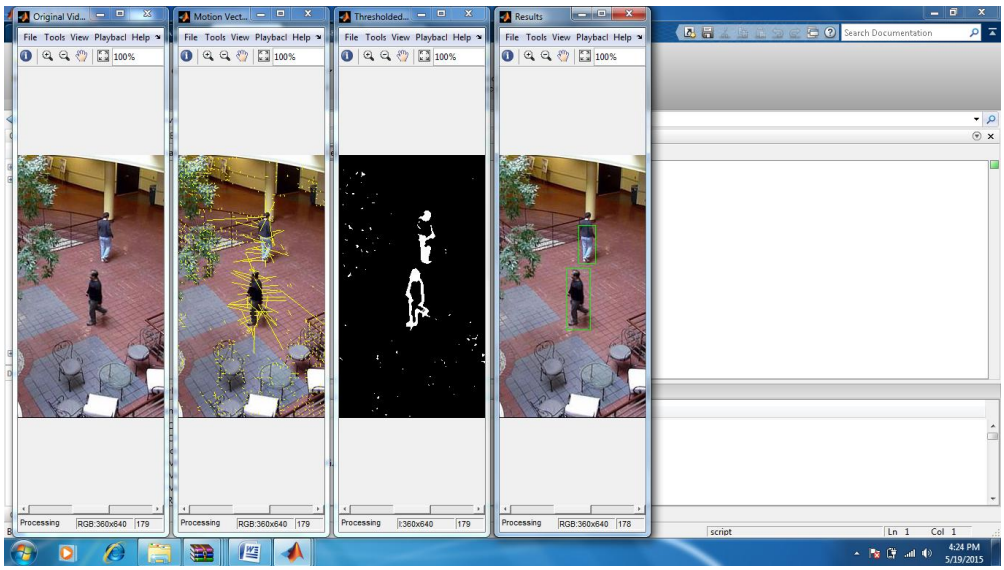


Figure 5.6:- Multiple object tracking by optical flow (video 2)

❖ **RESULTS FOR VIDEO 3**

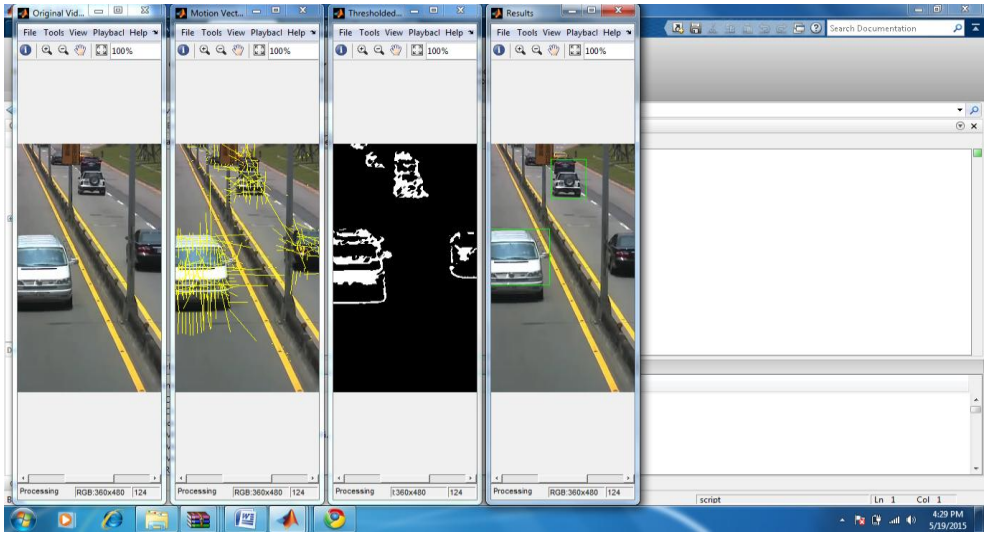


Figure 5.7:- Multiple object tracking by optical flow (video 3)

- **RESULTS FOR VIDEO 4**

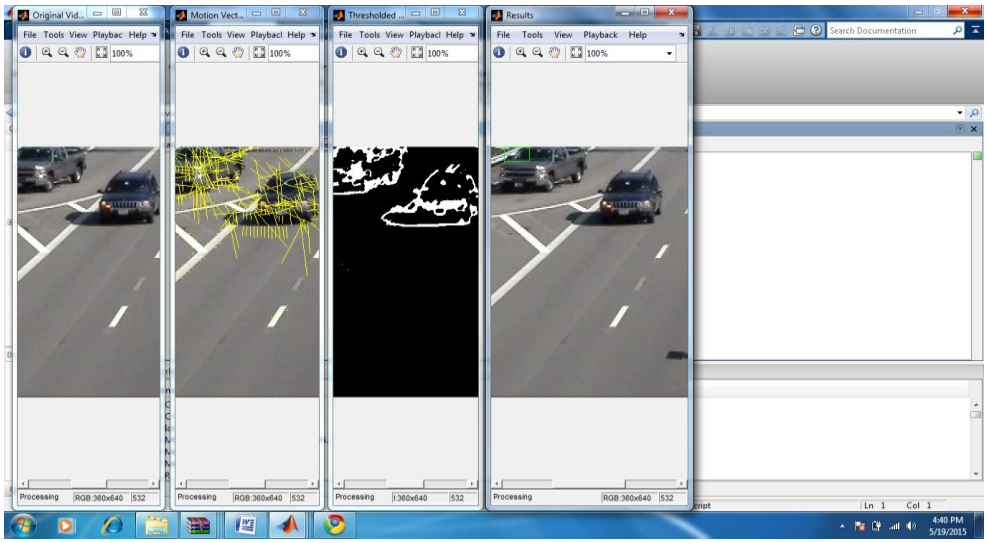


Figure 5.8:- Multiple object tracking by optical flow (video 4)

5.4 RESULT FOR REAL TIME OBJECT TRACKING

- **RESULTS FOR VIDEO 1**

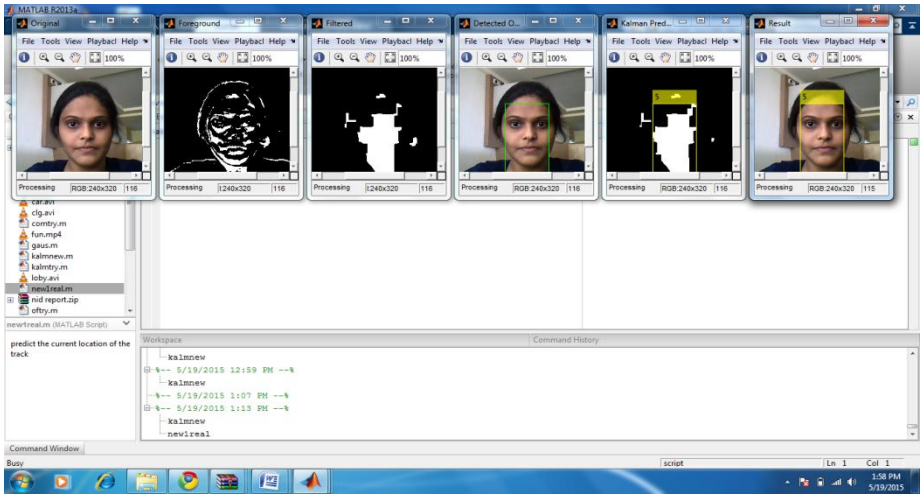


Figure 5.9:- Real time object tracking by kalman filter (video 1)

5.5 COMPARISON OF PROPOSED METHOD WITH EXISTING METHOD

For the comparison, three different video stream is taken one is Atrium video, second one is Vision traffic video and third one is the two track video. Comparison between all these three methods is done by the Recall and Precision value. Recall is the percentage of the desired items that are retrieved whereas Precision is the percentage of retrieved items that are desired items. Recall and Precision can be calculated by using the equation (1) and (2) respectively.

$$\text{Recall} = \frac{\text{Correct}}{\text{Correct + Missed}} \quad (1)$$

$$\text{Precision} = \frac{\text{Correct}}{\text{Correct + False positive}} \quad (2)$$

Table 5.1 Experimental data

Method Used	Video Type	Total moving object	Object Tracked	Correct object	Missed object	False object	Recall	Precision
Optical Flow	Atrium.avi	9	13	8	1	5	88%	61%
	Visiontraffic.avi	7	5	5	0	2	100%	71%
	Twotrack.mp4	17	16	16	1	1	94%	94%
Kalman	Atrium.avi	9	10	9	0	1	100%	90%
	Visiontraffic.avi	7	7	7	0	0	100%	100%
	Twotrack.mp4	17	17	17	0	0	100%	100%

From Table 5.1 the precision and recall value of optical flow method is low as compare to kalman filter method. Optical flow method [1] is to calculate the image which are in the optical flow field, and do clustering processing according to the optical flow distribution characteristics of image. With the help of this method we can get the complete movement information of object and detect the moving object from the background better, however, in this method a large quantity of calculation, very sensitive to noise, poor anti noise performance, make it not suitable for real-time demanding occasions. Here multiple or single object tracking algorithm based on Kalman filter. In this tracking approach first to establish the motion model of Kalman filter to choose centroid and tracking window as the features.

After that selecting the center of mass for moving object and tracked the window as the feature. With the help of matching features information of object is established. By using matching features results of moving object is updated. For the next frame we can take a updated model as an input parameters. So tracking of object is continuously achieved. By experimental results of different video we can prove that kalman filter is effective and robust algorithm for tracking. Kalman filter works in indoor as well as outdoor environment and matching performance is effective. By Table 1 the recall and precision value is better than the optical flow method.

VI. CONCLUSION

Object detection and object tracking is an important task in computer vision field. In object detection and object tracking it consist of two major processes, object detection and object tracking. Object detection in video image obtained from single camera with static background that means fixing camera is achieved by background subtraction approach. In this thesis, we tried different videos with fixed camera with a single object and multiple objects to see it is able to track objects.

There are many methods available for object detection and object tracking. Here we have used the Gaussian mixture modeling for object detection and kalman filter for object tracking. By using kalman filter with Gaussian foreground, multiple objects are detected quite efficiently and also tracked by kalman filter. we have also implemented the proposed method in real time video. we have compared proposed method with existing methods and prove that through proposed method we have got better result compared to existing methods.

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