# Implementation Of Movement Detection And Tracking Objects From Video Frames Using Image Processing

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**Abstract:** The moment detection and tracking in a video surveillance system video is a challenging framework. This paper aimed to detect the motion from video frames of compressor JPEG format. The approaches for motion detection using the sum of absolute difference. Once after performing motion detection, tracking the objects is processed for behavioral analysis. A Kalman filter method is applied to predict the position of an object. The video from the stationary camera and static background trajectory movement, and the direction of an object are relatively synchronized. The foreground detection and Kalman filters are used for object detection and motion tracking, respectively.

**Keywords:** Computer vision, SAD, Kalman filtering, object detection, Video surveillance

## 1. Introduction

Detection and tracking of an object are significant features in the study of a CCTV surveillance system. It turns the mining of the data from video frames; it can be numerous vision-based applications. The CCTV surveillance system is used for monitoring motion in focus, analyzing traffic. It shows that finding and tracking an object is a significant field study area in computer vision-based surveillance systems.

The current research work in Video Surveillance of numerous dissimilar methods enables different pros and cons. [1-2] developed a two-phased technique that does background recognition via a parametric approach, to optimize the results. Background elimination is applied to decrease the additional computation load. The primary constraint is the fine-tuning of the ghost background. This method is to attain an improved precision rate and to prepare a reliable system.

The research work [3-5] concentrates on one trial and results from another test. Therefore, separating background object assumptions was ended with incompatible—background separation without a ghost in an image area.

Identifying an object motion detection is performed with less computation is ignored in the research. However, it met high performance and accuracy. A multi-camera approach and 3-D modeling [6] are applied.

The research work is based upon the background segmentation of moving objects. Using Gaussian, an average of means and median methods improves accuracy [7]. The above explanation doesn't give way to implement economically. Utmost the techniques prepare their model by applying frames sequence explained in [8,9].

The author's [10] solution is to use one frame to initialize the background. The spatial domain pixels are selected to initialize the model. Then the segment information from the neighboring pixels is considered as temporal on a single frame. But it is unable to recall temporal data.

A single frame can't hold whole data and precise details of the color pattern of brightness from the successive frames. Therefore, the limitation of this method is uneven with noise environment—some more ways to detect ghosts in the first frame, as in [11]. The process that detects the moving objects operates an exclusive color model in the paper [12]. Identify and detect moving objects in a relatively static background and track their entire trajectory using the Kalman filter [13-15].

## 2. Methodology

To detect the motion and tracking, two primary goals to achieve the operation. Detecting object motion from the video frames is detected and stored.

Tracking is performed on the Stored frames to extract the features of foreground objects, and then the object motion is tracked.

The primary approach of the process is to have the video input stream. The object detection algorithm detects the motion from the video frames and stores it using the sum of absolute differences (SAD) [8,9].

In the beginning initialization of the software, parameters object setup is required. According to the category of motion detection, the usual flow of execution is done carefully for the threshold value initialized. As shown in Fig 1, the user has a choice to reach between the real-time video for surveillance and tracking [16,17]. The workflow captures the frames and processes them using motion detection algorithms with carefully choosing the method. If the motion is detected, then the Framework is encoded and stored in a separate directory. The process is continuous until we stop the operation. The next step is to track an object path from the movement detected frames. The log file automatically stores the time frame and frame number when the motion of an object is captured from the video frames. In the next step segment, the portions of the video frame are to isolate the foreground objects from background objects [18-20]. Thus, found the tracking of a moving object.

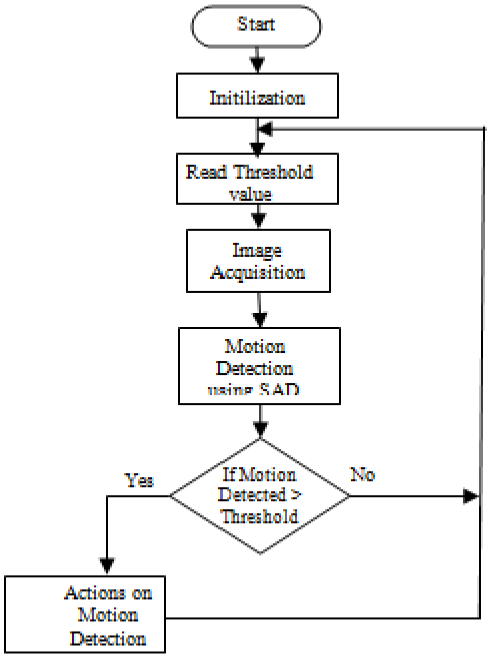



**Figure 1** Motion Detection flow chart

### 2.1 Motion detection

The primary goal is to recognize movements from the video and extract the given video stream outlines. To apply the calculations using the sum of absolute differences methods. The frames which contain the object movement or identified as well encoded these steps for capturing the video. The primary understanding of this process to use the still pictures from the recorded video. And then motion detection procedure is applied to the images to identify the moment and take an essential process. The figure demonstrates the general flow of the entire program.

#### 2.1.1 Algorithm approach for motion detection

To perform the motion recognition and the calculation part connects the recorded pictures. The moment detection using the sum of absolute differences. The difference in calculation method applied on the images for the numerical solution using an equation:

$$D(t) = \frac{1}{N} \sum \left| I(t_i) - I(t_j) \right| \qquad (1)$$

Where,

$N$ is the number of pixels in an image,

$I(t_i)$ $I$ at the time $i$ is an image, $I(t_j)$, $I$ at the time, j is an image.

Hence, $D(t)$ - it is the normalized SAD.

In the ideal case, without motion of an object $I(t_i) = I(t_j)$ and $D(t) = 0$ .

Nevertheless, commotion is constantly existing in the pictures, and an illustrative example of the images without movement is given by:

$$\mathrm{I}(\mathrm{t_i}) = \mathrm{I}(\mathrm{t_j}) + \mathrm{n}(\mathrm{t}) \quad \text{.............................................} (2)$$

Where,

$\mathrm{n}(\mathrm{t})$ - is a noisy signal.

The $D(t)$ speaks to the standardized aggregate of total distinction used as a basis of perspective that can be contrasted and limit esteem.

### 2.2 Actions on motion detection

The variations between the progressive casing system and the point of fluctuations on the set of the pictures will record the change. The variation appears within the limit, subsequent actions underneath, as shown in Fig 2. The significant steps are to update the log information with the date, time, and frame number. And to display the image, make use of the display image to convert it into the frame. The frame is encoded using the JPEG format. The number is supplementary to identify movement as it is recorded in the log document mainly to distinguish the moving objects that will show the change in a motion picture.

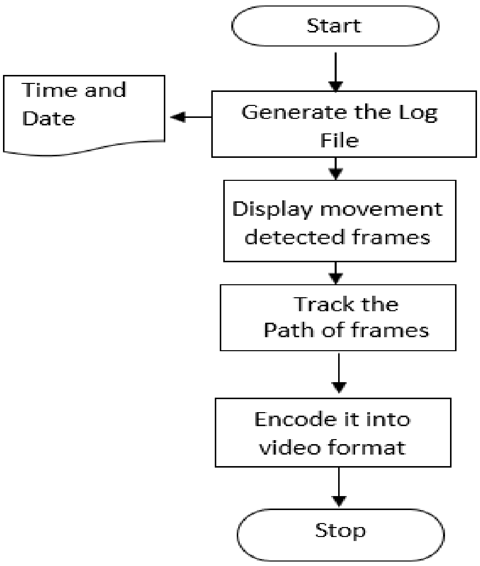



**Figure 2** Actions on Motion Detection

## 3. Object Tracking And Kalman Filtering

Initially, the image background is a snapshot of the motionless scene by default. After the background selection from the images gets extracted by reducing the background pictures and s**orted the accumulated pixel variations** to find the object which got varied in the pixel information. The most significant variations are located in the centroid and depending upon the accesses calculated to store the value. The radius of the object is also extracted by the area be in the circle. Therefore, plot the object detection circle around it, which is drawn in green color and represents the object as we conduct the centroids to determine the object's movement in the path. The primary constraint is getting the background's snapshot as a surface where the activities take place.

### 3.1 Path estimation

The primary approach is to detect each image by using a background reduction concerning an object's foreground image, which will extract the moving position of an object. To detect the most prominent object is processed in the foreground using bubble sorting and checking the large object. So the centroid radius of an object will find and is indicated with a green circle for the detected object. The radius and the centroid parameters fit the Kalman filter to assume the values. Marked with a red circle to collect the values taken from the Kalman filter as it floats to connect the centroids, remaining part of the movement of an object.

**3.2 Kalman filtering**

The Kalman filtering method is to evaluates a lot of practical estimation methods. The measured variables of advances in the straight condition and assessment of the evaluated variable to detect the direct situation. The string method estimates the object position depending upon the objects stated previously by using Kalman filtering equations. These equations are helpful in the noisy environment, and they may be exposed to external disturbances or when the frame is missing in our data sets. Therefore, the Coleman filter estimates an object's VRL tracking position in each picture and marks a red circle.

To expand the clarification, we show a measurement Kalman channel. It needs to gauge an irregular variable x(t) fulfills a straight, powerful condition

x (tk + 1) = Fx (tk) + u(k) .................................. (3)

Where F is a known linear no.

The time t determines the dynamic x value.

u - white noise,

It isn't related to some additional arbitrary variable—background regular noise in equipment. An outstanding model is the similar voltage created in a resistor. When there are numerous uncorrelated sources of info, the total of it is a repetitive. The, Change is typically difference of u is Q enumerated in the formula:

Q = ( Σ k = 0n ( u(k) – m ) 2) / k where m = 0,

which gives Q = (Σ k = 0n u(k)2) / k .................................. (4)

Kalman formula:

Q = E[u2] .................................. (5)

Where,

E - the scaled value.

Value of X is $x_1$, $x_2$,. .,

X - probability distribution of a random variable

Probabilities $p_1$, $p_2$, ... $p_k$

Then its possible value:

E[X] = (i=1k $p_i$ $x_i$) . .................................. (6)

A Kalman filter desires a preliminary estimation $x_e$ of x ($x(t_0)$).

The change of the error calculation is

$P = E[(x(t_0) – x_e)^2]$ .................................. (7)

$x(t_1) = F_x(t_0) + u(0)$

We can approximate the value $x(t_1)$

newxe = $Fx(t_0) + u(0) = F_{xe} + u_e$ .................................. (8)

where u = 0,

Therefore, estimate of u (0), $u_e = 0$.

So, our approximation of $x(t_1)$ new $x_e = F_{xe}$

The approximation of variance is:

newP = $E[(x(t_1)$ – newxe) 2] = $E[(F_x(t_0) + u – F_{xe})2]$ = F2E[$(x(t_0) – x_e)2$] + E[$u_2$] + 2FE[$(x(t_0) – x_e) * u$]

.................................. (9)

u is not correlated to $x(t_0)$ and $x_e$,

$E[(x(t_0) – x_e) * u] = 0$, Therefore we can write it as

$$newP = PF2 + Q \quad ................................... (10)$$

measurement of x named y such that $y(1) = Mx(t_1) + w(1)$

M – is a number.

w - white noise where R value is a changed and its mean value is 0.

We can estimate the value of y(1): $y_e = M*newxe$

We can improve our approximation of $x(t_1)$ by the formula:

$$newerxe = newxe + K * (y(1) – M*newxe) = newxe + K * (y(1) – y_e) \quad ................................... (11)$$

K - Kalman gain.

To obtain the optimum value of K, calculate the variance of the resultant error:

$$newerP = E[ (x(t_1) – newerxe ) 2 ] = E [x - newxe - K * (y – M * newxe) ] 2 = E[ x - newxe - K * (Mx + w – M * newxe)] 2 = E[(1- KM) (x – newxe) + Kw ]2 = newP * (1 - KM) 2 + RK2 = newP * (1 - 2KM + K2M2) + RK2 \quad ................................... (12)$$

newerP is small, if the derivative newerP of K = 0,

$$K = M\ newP / (newP * M2 + R) \quad ................................... (13)$$

we originate that

$$newP = PF2 + Q, \quad K = M * (PF2 + Q) / ((PF2 + Q) * M2 + R) \quad ................................... (14)$$

Repeat the process for $t_2$, $t_3$ ..., the estimation error change will decrease. Therefore, estimation becomes more and more precise value. Using these equations, we can predict the position of the object for different periods.

## 4. Results

This section is supposed to apply motion detection, tracking, and a prediction method by Kalman filtering. After using all these methods, we can figure out the motion detection, tracking, and prediction, of an object across the video frames. In the first step, the motion detected frame is showed, the moment got caught by the program and extracted the frame numbers in the log file as shown in Fig 3.

```
Movement detected in frame number 00002
AT 25-Oct-2020 11:44:24
Movement detected in frame number 00003
AT 25-Oct-2020 11:44:25
Movement detected in frame number 00004
AT 25-Oct-2020 11:44:26
Movement detected in frame number 00005
AT 25-Oct-2020 11:44:27
Movement detected in frame number 00006
AT 25-Oct-2020 11:44:28
Movement detected in frame number 00007
AT 25-Oct-2020 11:44:29
Movement detected in frame number 00008
AT 25-Oct-2020 11:44:31
Movement detected in frame number 00009
AT 25-Oct-2020 11:44:32
Movement detected in frame number 00010
AT 25-Oct-2020 11:44:33
Movement detected in frame number 00011
AT 25-Oct-2020 11:44:34
Movement detected in frame number 00012
```

**Figure 3** Text file with frame number, date, and time of movement detected

Once the motion is detected, it stores the date-time and frame number in the text file. It indicates frame number date and time and the subsequent frame numbers, where the motion is detected. This information is more valuable in a surveillance system when the action is detected; it stores the movement that has occurred.

A plotted graph is the frame number on the x-axis and a variance value on the y-axis, as shown in Fig 4. The variance is measured depending upon the threshold variance value considered as the required data set. Then collective frames are stored in a database. Hence, the sum of the absolute differences (SAD) method is applied to video frames to track the object. The object tracking is marked in red color. And the position of the object is marked in green color. The measured calculations are by the Kalman filtering for prediction and updating the information in the subsequent frames, as shown in Fig 5.

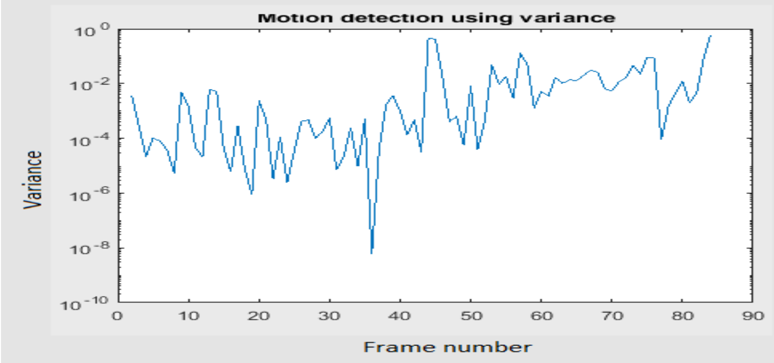



**Figure 4**: The variance between successive frames shown in the window

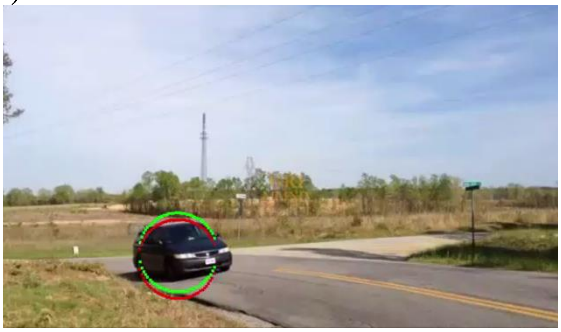
(a) (b)

**Figure 5**: The motion detected frame displayed a) Image without vehicle b) Image with a vehicle detected and the image stored in a database

The trajectory movement of a plotted object uses a tracking algorithm, as shown in Fig 6, to figure out the 2D and 3D plots of an object's motion; the variance between successive frames is shown in the window samples frame 1 to frame 70. Each frame shows marked circles in green and red on the object. It offers automatic detection of vehicles irrespective of the dimension of an object; it can sync dynamically in the surveillance location. The frames show the ultimate results of applying the method.

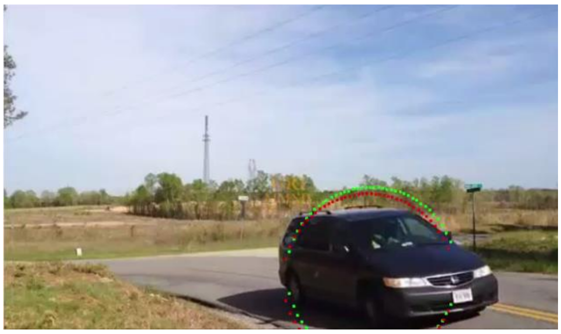
a) Frame 1

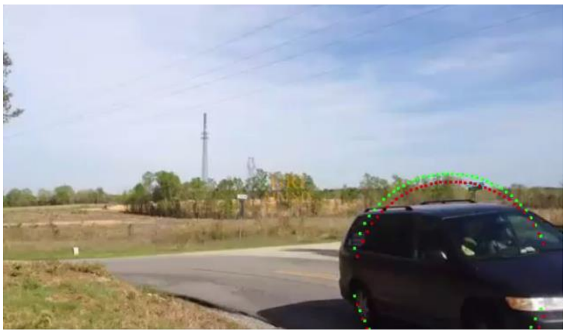
b) Frame 10



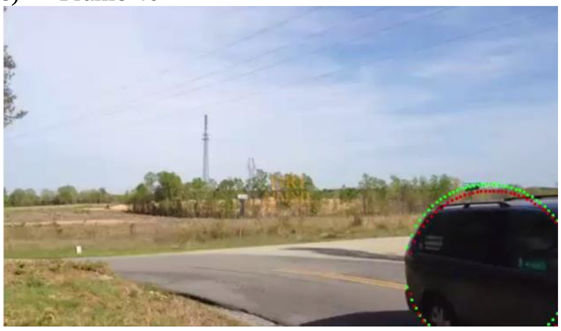
c) Frame 20

d) Frame 30





e) Frame 40 f) Frame 50



g) Frame 60 h) Frame 70

**Figure 6:** Tracking of object frame1 to frame 70 sample images from the database

Tracking begins when there is an object in the motion picture. The red circle and green circle show the position of the object calculated using Kalman prediction and updating, respectively.

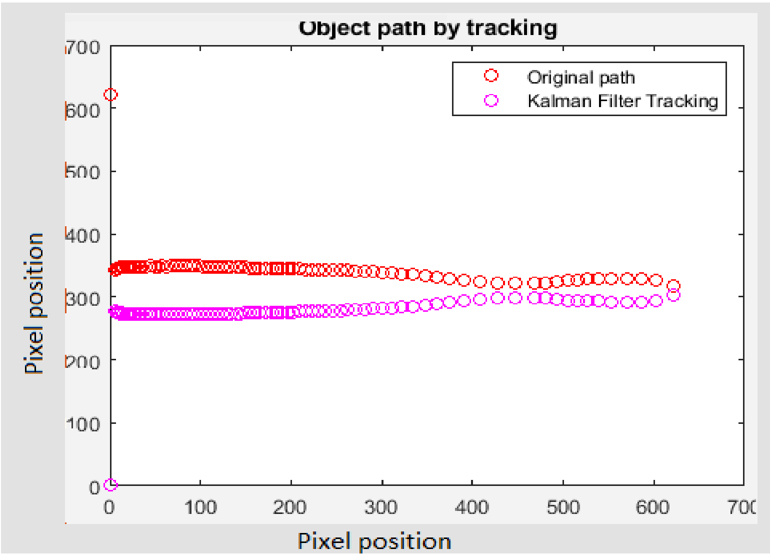



**Figure 7:** The 2-D path of an object plotted

The trajectory of the object's movement detected by using the tracking algorithm is a plot on a graph. The above pictures show the 2-D plot of the object's motion, as shown in Fig 7, which indicates the path prediction using Kalman filtering shows regarding pixel position in an image.

## 5. Conclusion

We have developed a motion detection and object tracking system. This paperwork is to track cars on the road. The method is quite capable enough to detect the objects dynamically about the location of it. The circles are drawn in the figure against the vehicle dynamically. The work enabled us to see the vehicle's direction, position, and trajectory moment and assume the vehicle's future location. This work may be helpful to identify the accidents that occurred under surveillance and store the required images in the database. We are using enormous memory space to store videos about the traffic condition in Terabytes. Memory usage can reduce significantly from

Terabytes to Megabytes. Therefore, only required information is stored when the detected object/vehicle on the road within the area of a surveillance system. The rest of the video is a waste of memory that we can avoid.

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