Project Report

Titled as

# "VEHICLE IDENTIFICATION AND COUNTING FOR TRAFFIC SURVEILLANCE"

***Submitted By***


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**Prajapati Snehal Mahendrabhai**

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***Towards partial fulfillment of the requirement for the award of the degree***

***of***

**BACHELOR OF ENGINEERING**

***in***

**ELECTRONICS AND COMMUNICATION**

***Under the Guidance of***

**Prof. Kinjal Vagadia**


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CHANDKHEDA, AHMEDABAD-382424

**Gujarat Technological University, Ahmedabad**


May, 2013

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ELECTRONICS AND COMMUNICATION

May, 2013

# <u>CERTIFICATE</u>

**Date:**

This is to certify that the project entitled "**Vehicle identification and counting for Traffic Surveillance**" has been satisfactorily carried out by **Patel Milankumar A. (090170111064)**, **Prajapati Snehal M. (090170111067)** and **Pathak Rutvik M. (090170111011)** under my guidance towards partial fulfillment of the requirement for the award of degree of Bachelor of Engineering in Electronics and Communication($8^{th}$ Semester) of Gujarat Technological University, Ahmedabad during the academic year 2012-13.

| | |
|---|---|
| **<u>Project Guide</u>:** | **<u>Head of Department:</u>** |
| **Prof. Kinjal Vagadia** | **Dr. Mihir Shah** |
| Assistant Professor, | Assc. Professor and Head, |
| EC Department | EC Department |

# DECLARATION

We declare that the work carried out as per the report, 'Vehicle identification and counting for Traffic Surveillance' submitted here with to fulfill the requirements for the award of Bachelor of Engineering Degree in Electronics and Communication Engineering from Gujarat Technological University(G.T.U.) is not submitted at any other University/Institute for any degree or diploma. We also declare that the reported work is carried out by us and the reported results are obtained in experiments/simulations performed by us and there is no manipulation or fabrication in the same.

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# ACKNOWLEDGEMENT

I wish to express my heartfelt appreciation to all those who have contributed to this project both explicitly and implicitly. Without their cooperation it would not have been possible to complete this project.

Needless to mention that Prof. Kinjal Vagadia had been a source of inspiration. I am thankful to her for her timely guidance and valuable assistance in the project work.

I would also thank our respected Head of the Department Dr. Mihir V. Shah for his kind support and cooperation.

Finally, yet importantly, I would like to express my heartfelt thanks to my beloved parents for their blessings, my friends/classmates for their help and wishes for the successful completion of this project.

# ABSTRACT

Video Surveillance systems provide quick practical information resulting in increased safety and smooth traffic flow. These systems are focused on background modeling, moving object classification and tracking. The objective is to identify and count the number of vehicles on the road to reduce complexity at traffic intersections. It will help detecting congestions, traffic signaling and diverting also in power requirements for hoardings according to number of vehicles.

The present algorithm for counting vehicles in image sequences for traffic scenes are recorded by a stationary camera. Initially, a video clip is read and decomposed into a number of frames then background image is found. Then we have to identify the foreground dynamic objects. Then, the frame consisting of only dynamic objects is obtained and converted into a binary image. The presence of an object is indicated in white color using morphological processing techniques. A counting algorithm is applied to count the number of objects. The entire coding is carried out in MATLAB 2012a version.

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# Chapter 1

# INTRODUCTION

## 1.1 Introduction

In recent year, as a result of the increase in vehicle traffic, many problems have appeared. For example, traffic accidents, traffic congestion, traffic induced air pollution and so on. Traffic congestion has been a significantly challenging problem. It has widely been realized that increases of preliminary transportation infrastructure e.g., more pavements, and widened road, have not been able to relieve city congestion.

**Figure 1.1: Frame from typical traffic monitoring video sequence (Ref [1])**

As a result, many investigators have paid their attentions on intelligent transportation system (ITS), such as predict the traffic flow on the basis of monitoring the activities at traffic intersections for detecting congestions. To better understand traffic flow, an increasing reliance on traffic surveillance is in a need for better vehicle detection such at a wide-area. Automatic detecting vehicles in video surveillance data is a very challenging problem in computer vision with important practical applications, such as traffic analysis and security.

Vehicle detection and counting is important in computing traffic congestion on highways. A system like the one proposed here can provide important data for a particular design. The main objective of our study is to develop methodology for automatic vehicle detection and its counting on highways. We present a system for detecting and tracking vehicles in surveillance video which uses segmentation with initial background subtraction using morphological operator to determine salient regions in a sequence of video frames. Edges will be counting which shows how many areas are of particular size then particular to car areas we locate the points and counting the vehicles in the domain of traffic monitoring over highways.

## 1.2 Motivation

This project is mainly focused on developing a system that can count the number of vehicles that passed through a road. Vehicle density is increasing day by day and accidents are also increasing, but it is very difficult to manage vehicle density manually with accuracy in 24x7 and in all weather conditions. To plan a better system these type of automated system is essential.

Thus we plan to develop a system to detect and count dynamic objects efficiently. Intelligent visual surveillance for road vehicles is a key component for developing autonomous intelligent transportation systems. The algorithm does not require any prior knowledge of road feature extraction on static images.

## 1.3 Contribution

A system has been developed to track and count dynamic objects efficiently. Intelligent visual surveillance for road vehicles is a key component for developing autonomous intelligent transportation systems. The algorithm does not require any prior knowledge of road feature extraction on static images.

We present a system for detecting and tracking vehicles in surveillance video which uses a simple motion model to determine salient regions in a sequence of video frames. Similar regions are associated between frames and grouped to form the background. The entire process is automatic and uses computation time that scales according to the size of the input Video sequence. We consider image/video segmentation with initial background subtraction, object tracking, and vehicle counting, in the domain of traffic monitoring over an intersection.

## 1.4 Problem Statement

The problem is to identify, track and count vehicles that passed through a point. The system must be non-contact, non-invasive. System should work in real time and should have more than 90% accuracy.

## 1.5 Objectives

The objective is to develop and implement a vision based system which can count vehicle which passed through a road. A video of the highway or any road with moving vehicles are taken. For that purpose, a vehicle detection algorithm is used. A method has to be developed which implements the most efficient vehicle detection algorithm.

Different Image processing algorithms are used to extract the Moving vehicle, and to count them. The video will be made during bright daylight conditions. This project aims at developing a system which effectively detects, count vehicle which passed through a road. The System for Highways shall be developed with an aim to monitor traffic, and planning traffic and to increase the safety in highways.

## 1.6 About MATLAB

MATLAB (“MATrix LABoratory”) is a tool for numerical computation and visualization. The basic data element is a matrix, so if you need a program that manipulates array-based data it is generally fast to write and run in MATLAB.

MATLAB provides many useful functions for working with matrices. It also has many scalar functions that will work element-wise on matrices (e.g., the function sqrt(x) will take the square root of each element of the matrix x). You will find many functions, many more in the MATLAB help index, and also in the “Other Resources” listed at the end of this handout.

In recent version of MATLAB, it includes Computer Vision Toolbox and many more such tools to do work into Artificial Intelligence and related field. MATLAB started as an interactive program for doing matrix calculations and has now grown to a high level mathematical language that can solve integrals and differential equations numerically and plot a wide variety of two and three dimensional graphs.

KEY FEATURES:

- High-level language for technical computing
- Development environment for managing code, files, and data
- Interactive tools for iterative exploration, design, and problem solving
- Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, and numerical integration
- 2-D and 3-D graphics functions for visualizing data
- Tools for building custom graphical user interfaces

In short, MATLAB provides a number of features for documenting and sharing your work. You can integrate your MATLAB code with other languages and applications, and distribute your MATLAB algorithms and applications.

# Chapter 2

# RELATED WORK

## 2.1 Technical Approach

For this project, a set of videos will be used. The system will use the MATLAB library for image processing. The video shall be read frame by frame, and motion detection algorithms used to detect the image region of the moving vehicle. Thus each moving object identified as vehicle (size) is used for counting the number of vehicles. The camera should be calibrated for obtaining the actual dimensions of the vehicle thus detected. The vision based system consists of three models:

- Vehicle detection
- Vehicle recognition
- Vehicle counting

Project is implemented using computer vision in MATLAB Library. This approach uses a camera to capture video of vehicle pass through highways and any road. Video is extracted to frames, vehicle is detected by analyzing the image frame by frame from the source video, Computer vision and image processing techniques are used for detection, counting of moving objects. Background Subtraction and Blob Detection techniques are used in order to detect and identify the moving object.

## 2.2 Scope

In this Proposed Project, vehicle is detected by analyzing the image frame by frame from the source video, here we are using camera for capturing the video, from the captured video using some image processing Algorithm (using MATLAB library) we extract he background and find out the Vehicle and motion detection algorithm is applied for detecting the motion.

Then counting them, this model will find out the number of vehicles. Using one graphical user interface all the parameters can be viewed, after that we can store all these data in database for future manipulation and planning.

## 2.3 Block Diagram

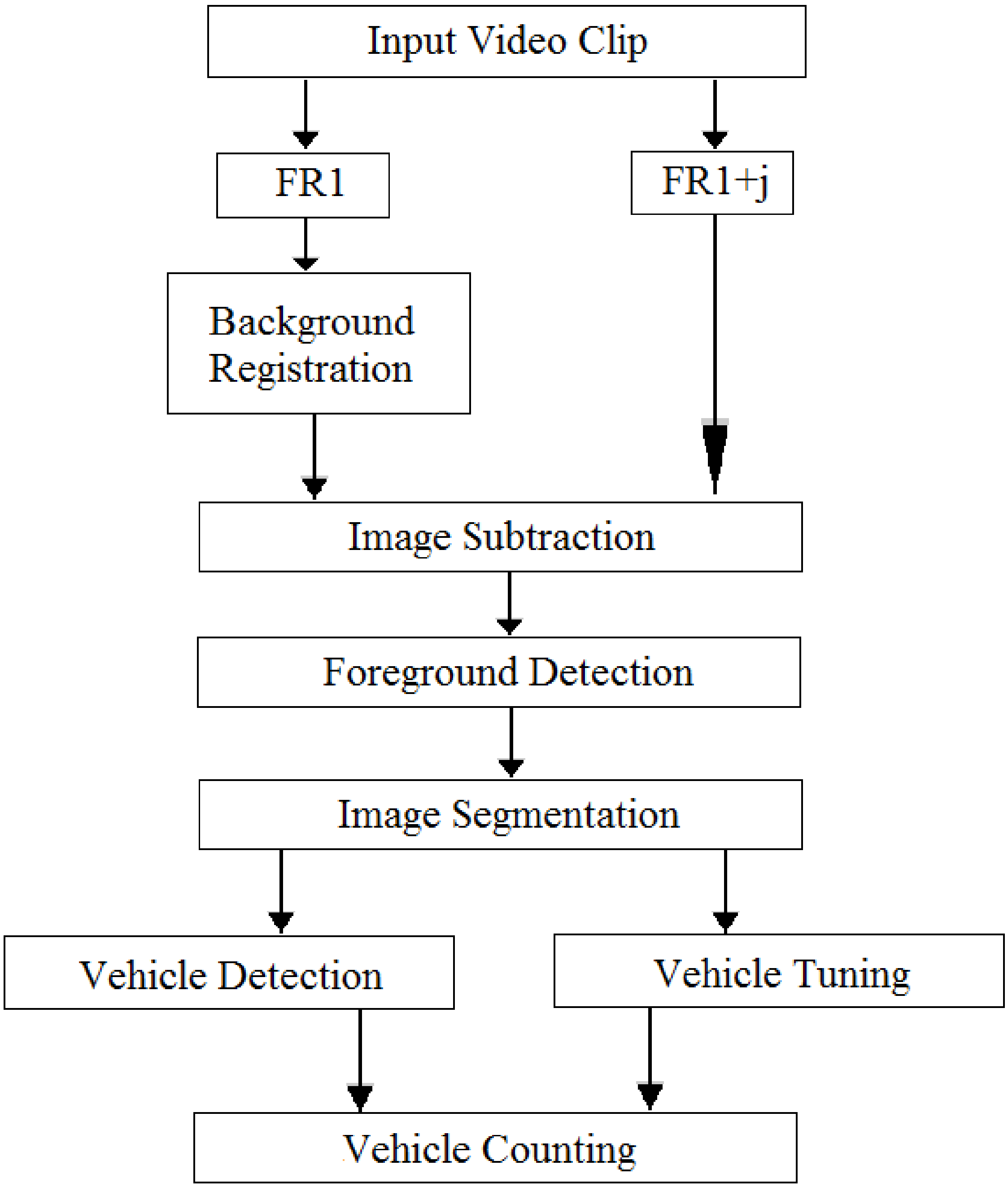



**Figure 2.1: Block Diagram (Ref [3])**

## 2.4 ARCHITECTURE AND MODELING

- In many real-time applications like video conferencing, the camera is fixed. Some techniques use global motion estimation and comparison to compensate the change in background due to camera motion.

- In this algorithm, we assume a stationary background for all video sequences. The architecture and modeling of the present paper is presented in Figure 1. Initially, a video clip is read and decomposed into a number of frames.

- Next, using these frames as inputs, the stationary background image is registered. The next phase is identifying the foreground dynamic objects, which is obtained by subtracting background image from the given input video frame. The following phase is the post processing phase where interference of noise is being minimized.

- Then, the frame consisting of only dynamic objects is obtained which is then converted into a binary image, where presence of an object is indicated as a white patch while the rest of the area is made to appear black. This is achieved using morphological processing techniques (dilation), which is applied to the binary image to group the different segments of a single object into one logical object.

- Structuring elements for dilation are chosen based on the video sequences. A counting algorithm is then applied to the resulting image to assist in counting the number of objects.

## 2.5 Functional Requirements

- Capture Video

The system shall be able to capture the video stored in the disk. This video shall be extracted to successive frames. System should work on line mode (input data directly from camera) and offline mode (input data from saved video on hard disc)

- Background Extraction

The system shall be able to separate the background components (still objects in the video) from foreground objects (moving objects. vehicle, pedestrian etc)

- Vehicle Detection

In image processing, a blob is defined as a region of connected pixels. Blobs are identified from the extracted Foreground objects after the Process of Background separation. Vehicle is detected using blob analysis and detection. Blob analysis is the identification of these connected regions in the image. The group of pixels for one connected region is considered as single blob. A single blob contains several connected pixels.

In order to detect the blobs, background subtraction is performed and detects the foreground pixels. The foreground pixel corresponds to moving vehicles. To produce the blob of moving vehicle, binary thresholding is done. The image may contain noise and this noise can be removed by preprocessing the image. Blobs are detected in the foreground image and the area of the blob is calculated. A bounding box is drawn around the detected blob and it is identified as the vehicles.

- Counting

After identifying the Blobs (Vehicles) using counting algorithm vehicles should be count and classify correctly.

# Chapter 3

# SYSTEM OVERVIEW

## 3.1 Video Capturing

Video tracking is the process of locating a moving object (or several ones) in time using a camera. An algorithm analyses the video frames and outputs the location of moving targets within the video frame. The main difficulty in video tracking is to associate target locations in consecutive video frames, especially when the objects are moving fast relative to the frame rate. Here, video tracking systems usually employ a motion model which describes how the image of the target might change for different possible motions of the object to track.

A live video capture module is developed to digitize live video signals into image frames from common video sources, such as a surveillance cameras or Digital camera.

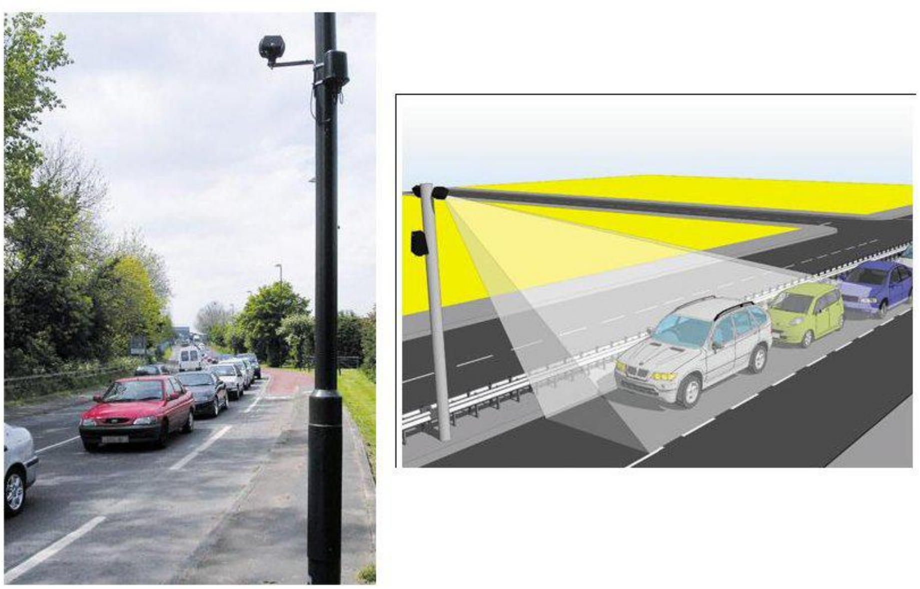


**Figure 3.1: Mounted camera on lamp post to capture vehicle video (Ref [2])**

Camera is mounted on a lamp post in such a way that the occlusions of vehicle moving toward both side is less so that we get a top long view of vehicles , the image format of the Joint Photographic Experts Group (JPEG) and the video format AVI (Audio Video Interleave) frame rate of 30 frames per second (fps) are adopted. When the System is running offline, it reads AVI video file from a storage media directly.

## 3.2 Background Extraction

In the scene, what interests us is the region corresponding to the motion (moving vehicles) rather than the entire view. Hence, the next step of the system is to isolate this region (called foreground) from the rest of the frame (called background).

The spatially large region of the frame which changes very slightly if at all during a long enough time interval (e.g. road / trees / buildings). Foreground extraction is used for separating the moving objects (vehicle) from the source video, only if we can successfully segment foreground can the following object detection, identification and tracking procedures be successful. So segmentation is the foundation to the whole surveillance system. Therefore, achieving a good segmentation result needs to be well considered

### 3.2.1 Image Difference

Image differencing is the most direct way that can be thought of for segmenting foreground regions. As implied by the name, the result is obtained by subtracting the current frame from a reference frame. So the difference of each method introduced below is which image is chosen as the reference image. Inter-frame differencing .The very basic approach is pixel-wise image differencing between two consecutive frames in the image sequence. The reference image is merely the previous frame of the video.

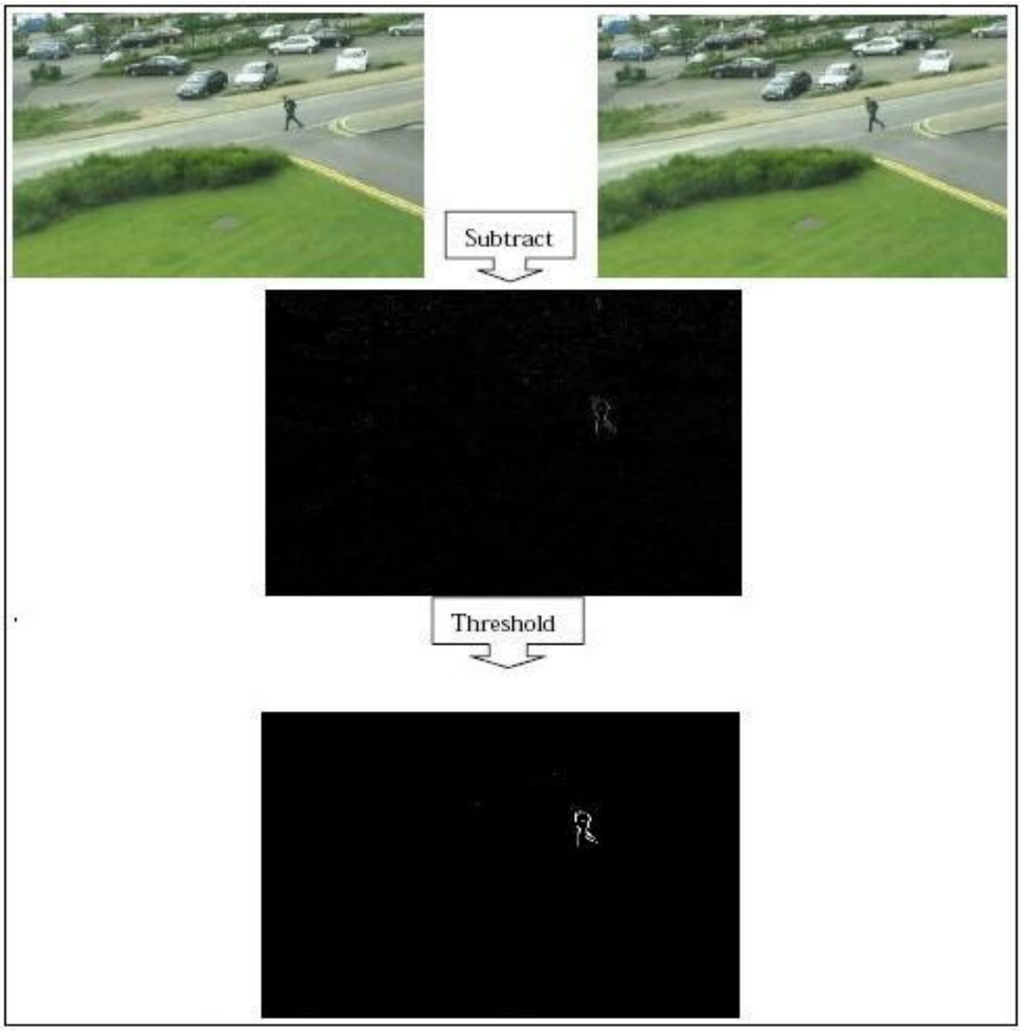



**Figure 3.2: Inter frame Differencing (Ref [3])**

The first step is to get the absolute difference between frames. Second, threshold the difference image. This method is very simple and adaptive to dynamic environments; however, it does a poor job to extract all the relevant pixels. As shown in Fig, when the object moves slowly, the moving distance between the same object in two frames is smaller than the size of the object itself, then the system can only detect the edge of the object or even nothing. The reason for this is the density values of the pixels on the same object are normally similar, so when the object does not have a large distance shift, the density value of the object's inner part appears as un-changed.

### 3.2.2 Background frame differencing

Now, creating a background image is discussed in more detail. One alternative is to give a reference image in advance; however, such an image will be useful only for a static camera with a constant background and lighting conditions. It absolutely cannot satisfy the demand of an outdoor visual surveillance system.

Simple background model suggests that the background image could be got by using mathematical or exponential average of successive images, the simplest form of which is time-averaged background image gives a background model.

This updating model gives larger weight to the background but less weight to the moving objects. It is very obvious, the older the current image becomes the less it contributes to the background model. Here, the background image is a weighted sum of past value and present frame.

Frame differences are computed by finding the difference between consecutive frames but this will introduce computational complexity in case the video clips having slow-moving objects. Moreover this algorithm assumes a stationary background. Hence the difference between the frames at regular intervals (say, some integer k) is considered. If there are n frames, then we will get (n/k) frame differences (FD). The frame difference follows Gaussian distribution as indicated in equation.

$$p(FD) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(FD-\mu)^2}{2\sigma^2}\right)$$

## 3.3 Background Registration

A general tracking approach is to extract salient regions from the given video clip using a learned back ground modeling technique. This involves subtracting every image from the background scene and thresholding the resultant difference image to determine the foreground image. Stationary pixels are identified and processed to construct the initial background registered image. Here we go by the fact that vehicle is a group of pixels that move in a coherent manner, either as a lighter region over a darker background or vice versa. Often the vehicle may be of the same color as the background, or may be some portion of it may be camouflaged with the background, due to which tracking the object becomes difficult. This leads to an erroneous vehicle count.

## 3.4 Background Elimination

Once the frame differences are computed the pixels that belong to the background region will have a value almost equal to zero, as the background is assumed stationary. Many a times because of camera noise, some of the pixels belonging to the background region may not tend to zero. These values are set to zero by comparing any two frame differences, say, FDi and FDj. Thus, the background region is eliminated and only the moving object region will contain non-zero pixel values. The images obtained after background elimination is as shown in the Figure.

## 3.5 Foreground Detection

The spatially small region of the frame which changes in a relatively short time interval (E.g. people/ vehicle / animals).

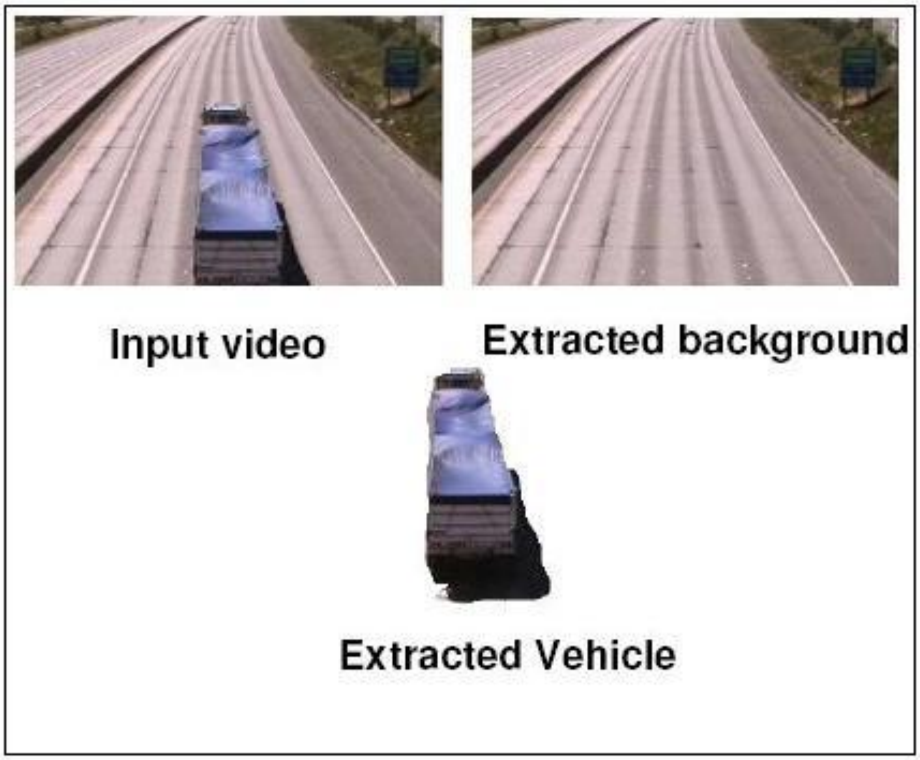



**Figure 3.3: Foreground Extraction (Ref [4])**

Most vision based traffic monitoring system must be capable of tracking vehicles through the video sequence. Tracking helps in eliminating multiple counts in vehicle counting applications and it also helps in deriving useful information while computing vehicle velocities. Tracking information can also be used to refine the vehicle type and also to correct errors which are caused due to occlusions. After registering the static objects the background image is subtracted from the video frames to obtain the foreground dynamic objects. Post processing is performed on the foreground dynamic objects to reduce the noise interference.

## 3.6 Post Processing

Many a times due to camera noise and irregular object motion, there always exists some noise regions both in the object and background region. Moreover the object boundaries are also not very smooth; hence a post processing technique is required. Most of the post processing techniques are applied on the image obtained after background elimination. Initially, order-statistics filters are used, which are the spatial filters and whose response is based on ordering (ranking) the pixels contained in the image area encompassed by the filter. The response of the filter at any point is then determined by the ranking result. The current algorithm uses Median filter which is the best-known order-statistics filter. This filter replaces the value of a pixel by the median of the gray levels in the neighborhood of that pixel.

The formula used is

$$f(x, y) = \text{median}\{g(s, t)\}$$

After applying the median filter, the resulting image is converted into a binary image. The morphological opening technique is applied on this binary image.

The opening of A by B is simply erosion of A by B followed by dilation of the result by B. This can be given as

$$A \circ B = (A\_B) \text{ XOR } B$$

Here, A is the image and B is a structuring element. After applying the above explained pre-processing techniques, the new image is obtained.

## 3.7 Image Segmentation

Segmentation refers to the process of partitioning a digital image into multiple regions. The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. The result of image segmentation is a set of regions that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic.

### 3.7.1 Identifying Blobs:

After background subtraction result is binary image to identify the blobs.
Main steps for blob Identification,

- Apply pyramidal transformation
- Apply blob detection algorithm
- Draw rectangle over the blobs
- Initialize and count each blob

**Blob Extraction:**

Blob Extraction is an image segmentation technique that categorizes the pixels in an image as belonging to one of many discrete regions. Blob extraction is generally performed on the resulting binary image from a thresholding step. Blobs may be counted, filtered, and tracked.

**Typical Blob Extraction Concept:**

An image is represented as a matrix with a certain number of pixels on a certain number of lines. When the image is grayscale, every one of those pixels has a value which indicates the brightness of the image at that point .Check the first line of the image and find groups of one or more white pixels. These are blobs on a certain line, called line blobs. Number each of these groups. Repeat this sequence on the next line.

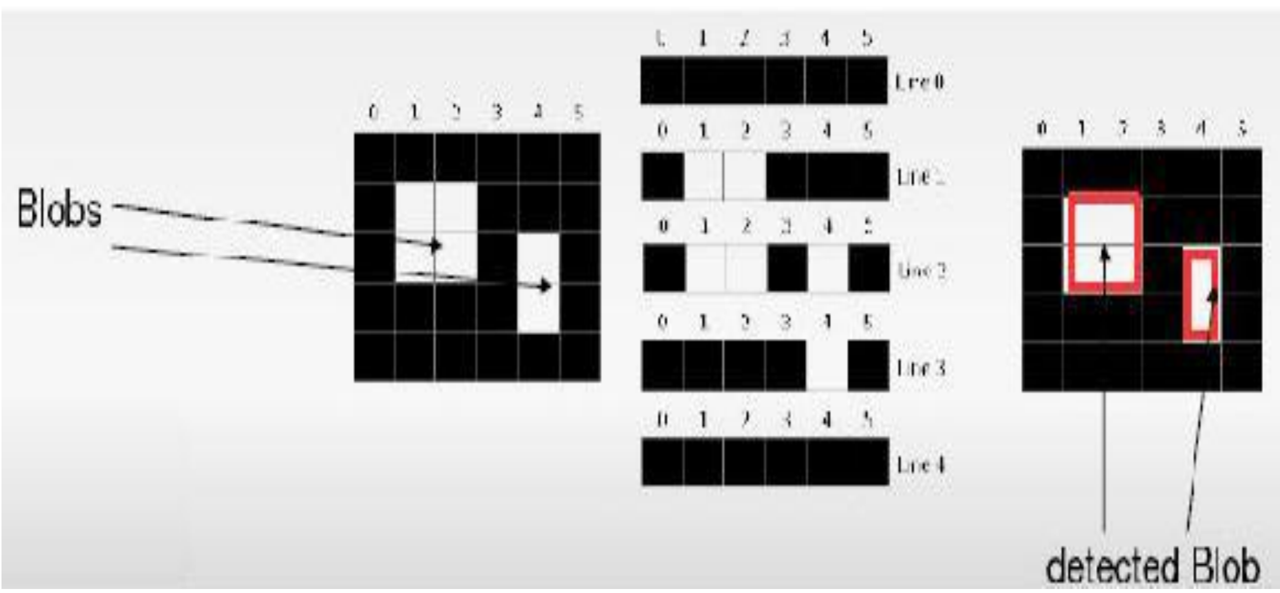
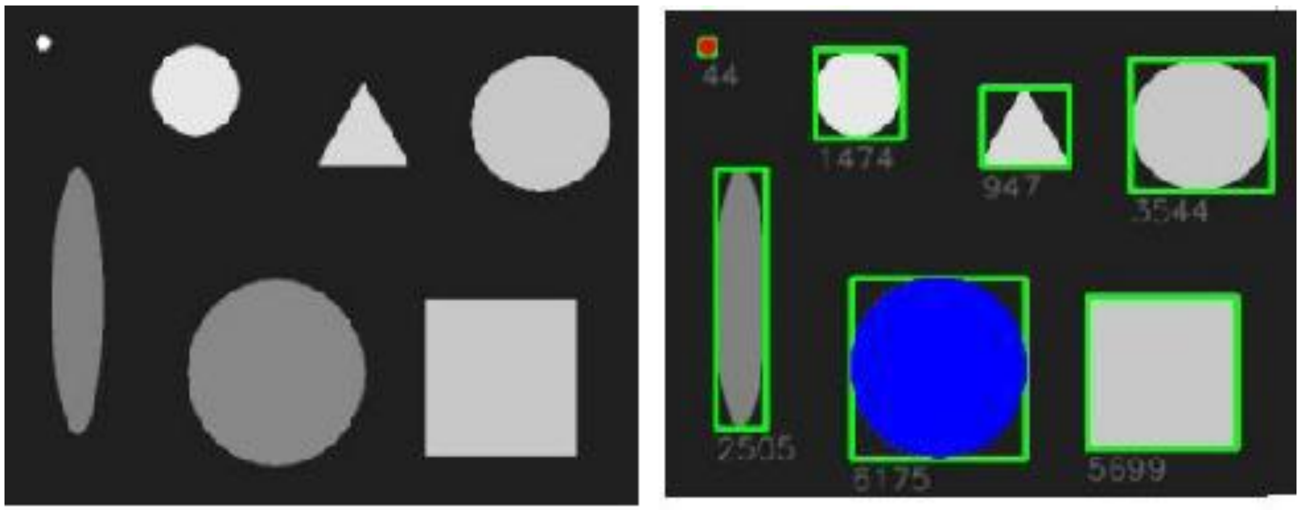



**Figure 3.4: Blob extraction Concepts (Ref [5])**




Input image with Blobs

Identified blobs and rectangle around them

**Figure 3.5: Blob extraction result (Ref [6])**

**Sequential algorithm:**

Create a region counter. Scan the image (in the above example, it is assumed that scanning is done from left to right and from top to bottom):

- For every pixel check the north and west pixel (when considering 4-connectivity) or the northeast, north, northwest, and west pixel for 8-connectivity for a given region criterion (i.e. intensity value of 1 in binary image, or similar intensity to connected pixels in gray-scale image).

- If none of the neighbors fit the criterion then assign to region value of the region counter. Increment region counter.

- If only one neighbor fits the criterion assign pixel to that region. If multiple neighbors match and are all members of the same region, assign pixel to their region.

- If multiple neighbors match and are members of different regions, assign pixel to one of the regions (it doesn't matter which one). Indicate that all of these regions are the equivalent. Scan image again, assigning all equivalent regions the same region value.

In the area of computer vision, 'blob detection' refers to visual modules that are aimed at detecting points and/or regions in the image that are either brighter or darker than the surrounding.

There are two main classes of blob detectors:

(i) Differential methods based on derivative expressions and

(ii) Methods based on local extrema in the intensity landscape.

With the more recent terminology used in the field, these operators can also be referred to as interest point operators, or alternatively interest region operators (see also interest point detection and corner detection).

There are several motivations for studying and developing blob detectors. One main reason is to provide complementary information about regions, which is not obtained from edge detectors or corner detectors. In early work in the area, blob detection was used to obtain regions of interest for further processing. These regions could signal their presence of objects in the image domain with application to object recognition and/or object tracking. In other domains, such as histogram analysis, blob descriptors can also be used for peak detection with application to segmentation.

Another common use of blob descriptors is as main primitives for texture analysis and texture recognition. In more recent work, blob descriptors have found increasingly popular use as interest points for wide baseline stereo matching and to signal the presence of informative image features for appearance-based object recognition based on local image statistics.

**Figure 3.6: Red Blob-Segment the region with motion (Ref [7])**

## 3.8 Vehicle Detection

Vehicle Detection is the process of identifying the vehicle that we extracted from the background, for identifying each vehicle we need to consider each vehicle as each blob then initialize each blob, count and classify them.

### 3.8.1 Object recognition

Object recognition in computer vision is the task of finding a given object in an image or video sequence For any object in an image, there are many 'features' which are interesting points on the object, that can be extracted to provide a "feature" description of the object. This description extracted from a training image can then be used to identify the object when attempting to locate the object in a test image containing many other objects. It is important that the set of features extracted from the training image is robust to changes in image scale, noise, illumination and local geometric distortion.

### 3.8.2 Object Identification

The image obtained after the pre-processing step has relatively less noise, so, the background area is completely eliminated. Now, if the pixel values of this image are greater than a certain threshold, then, those pixels are replaced by the pixels of the original frame. This process identifies the moving object as shown in Figure.

(a) Input image

(b) Foreground image

(c) Occlusion image

**Figure 3.7: Identified Object (Ref [8])**

# Chapter 4

# FLOW CHART

**Figure 4.1: Surveillance system flow chart**

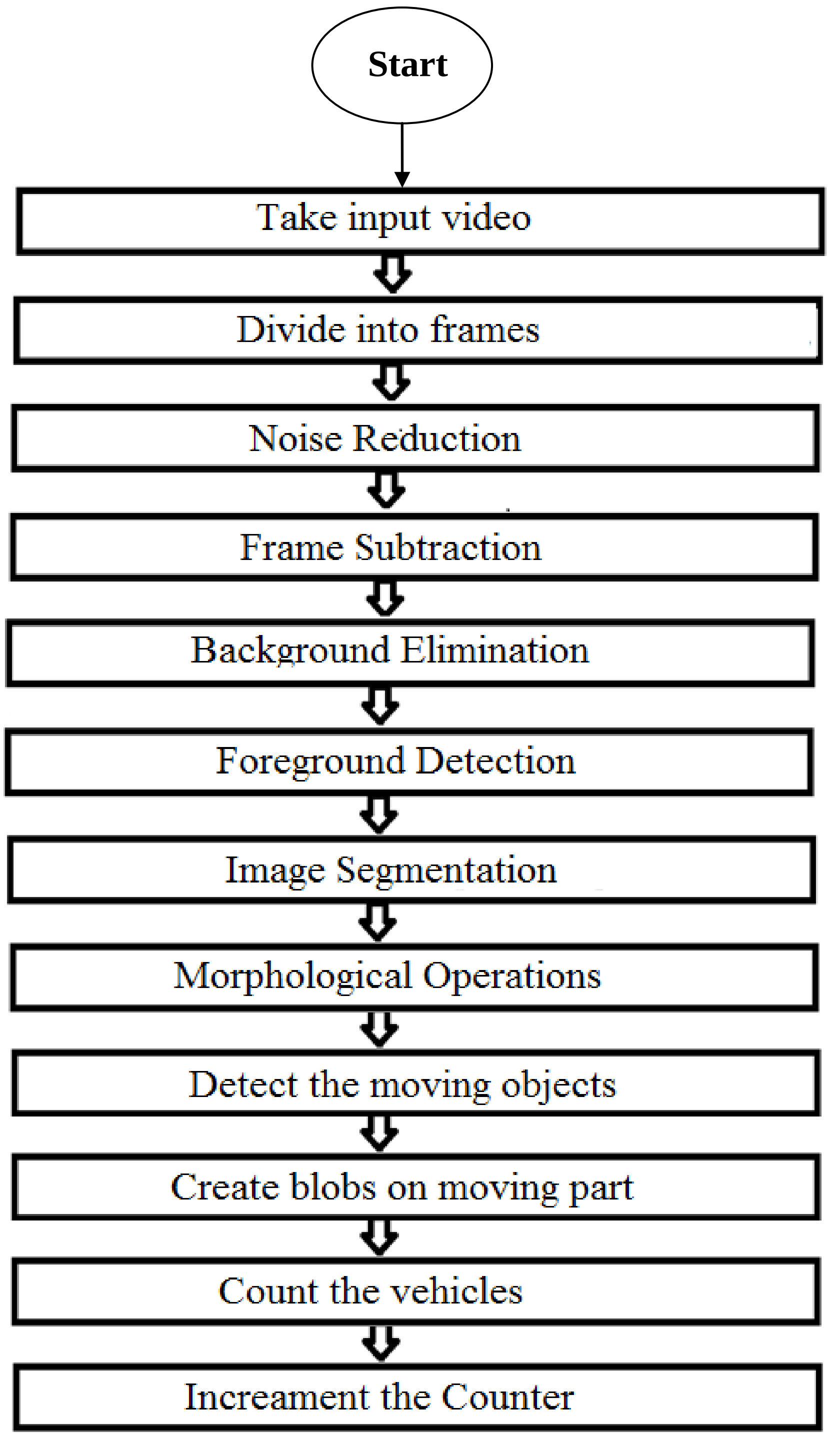


**Figure 4.2: Video Capturing**

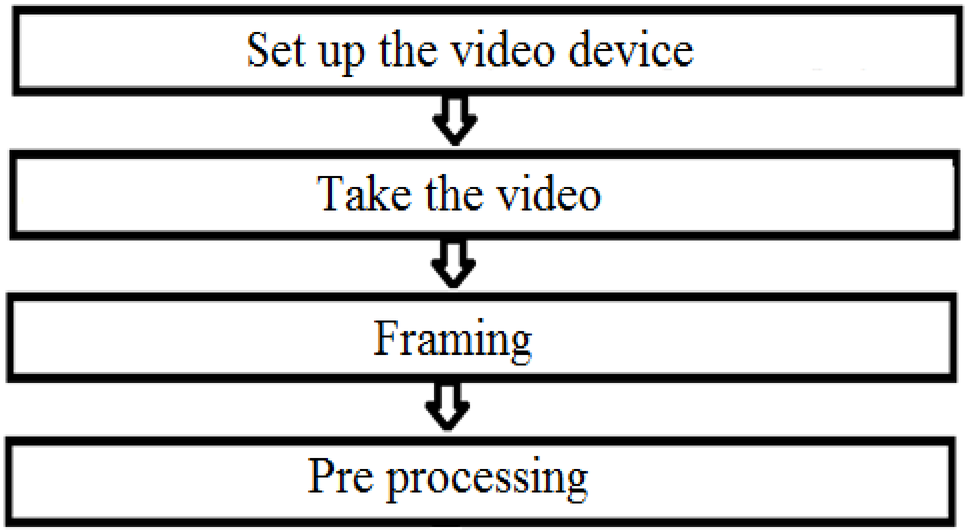


**Figure 4.3: Background Extraction**

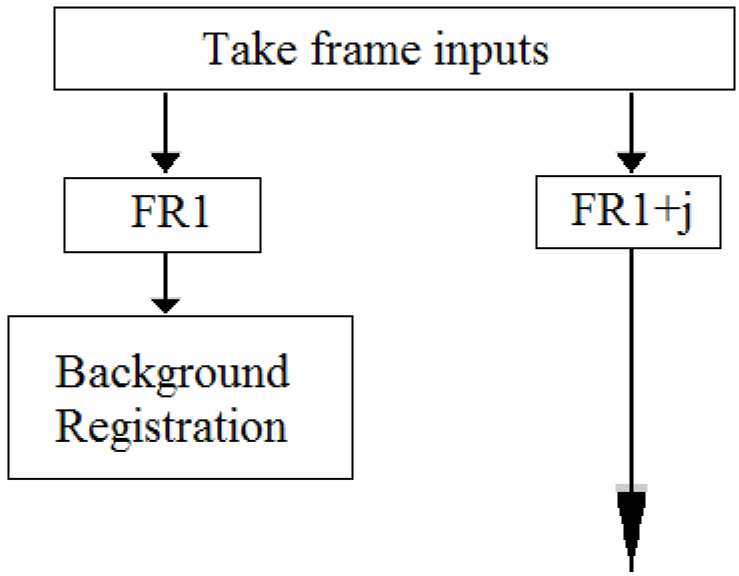



**Figure 4.4: Foreground Detection**

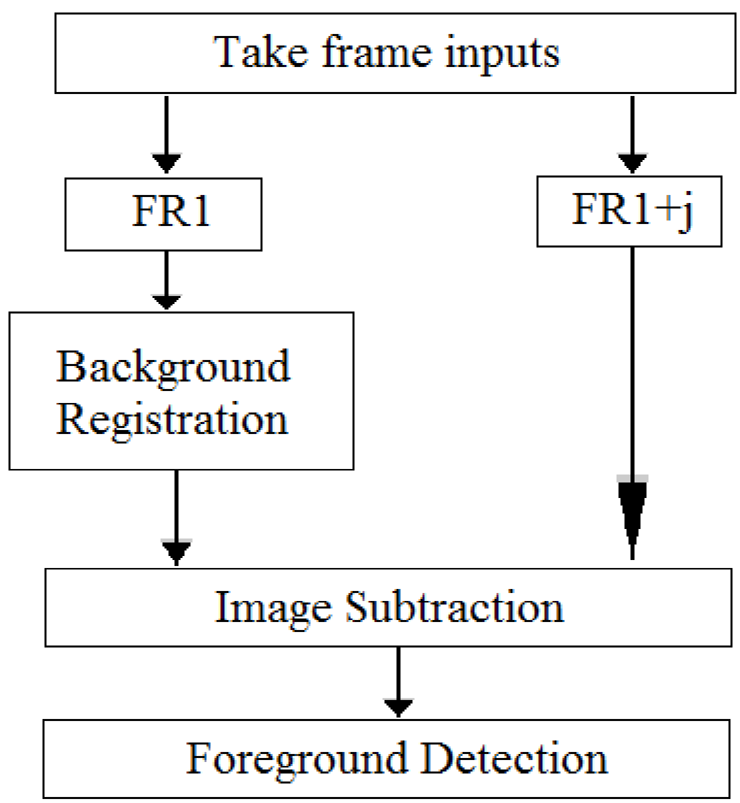


**Figure 4.5: Image Segmentation**

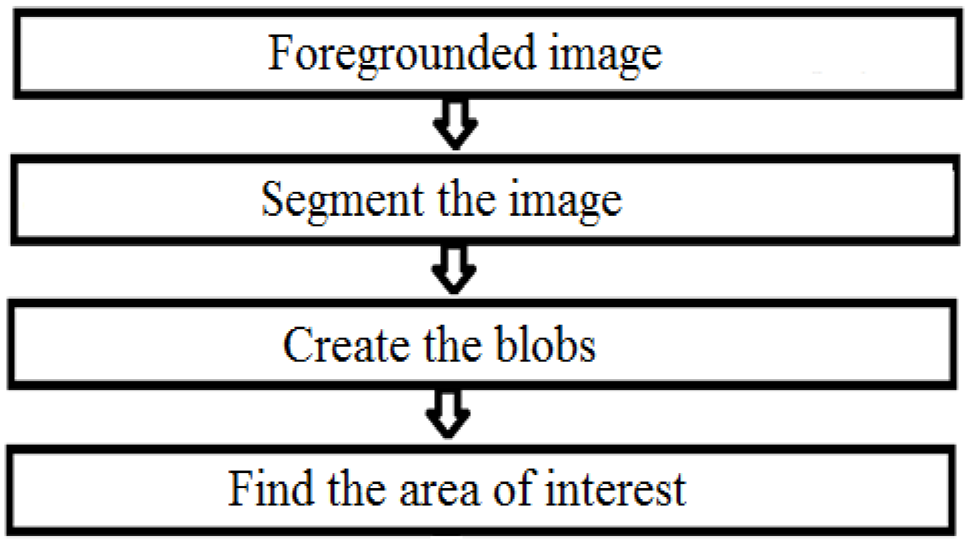
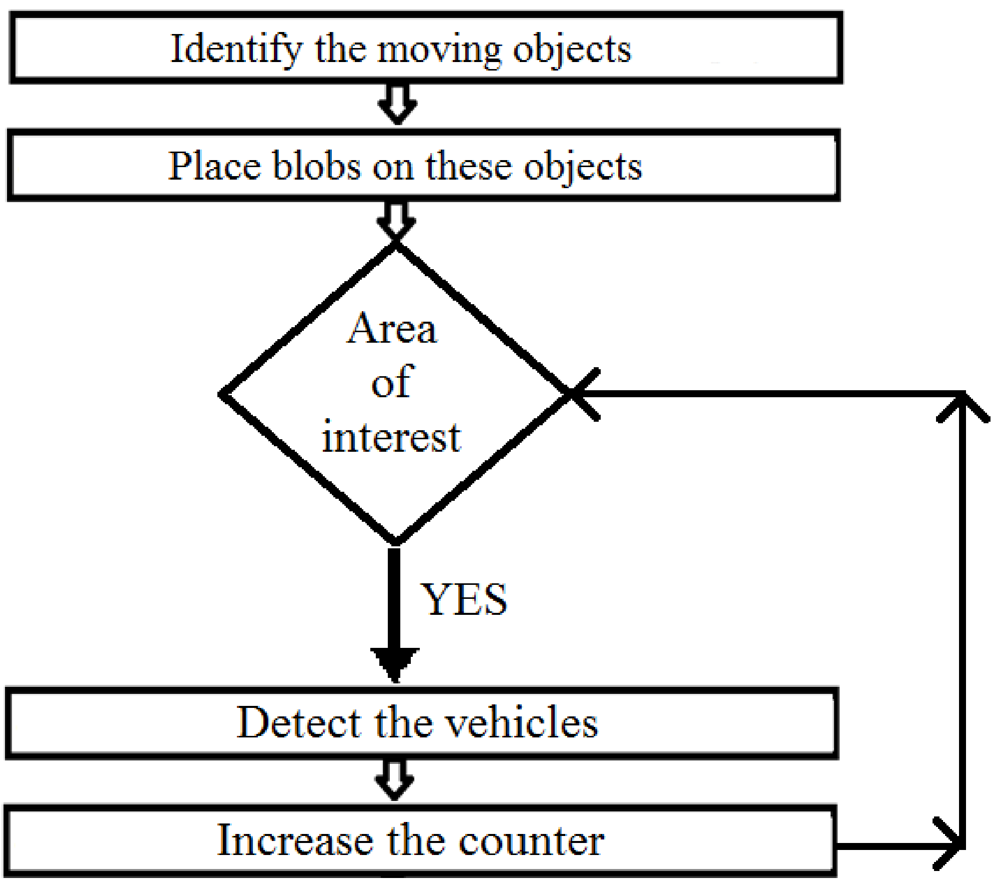



**Figure 4.6: Detection and counting**



# Chapter 5

# RESULTS ANALYSIS

**Figure 5.1: Input Video**

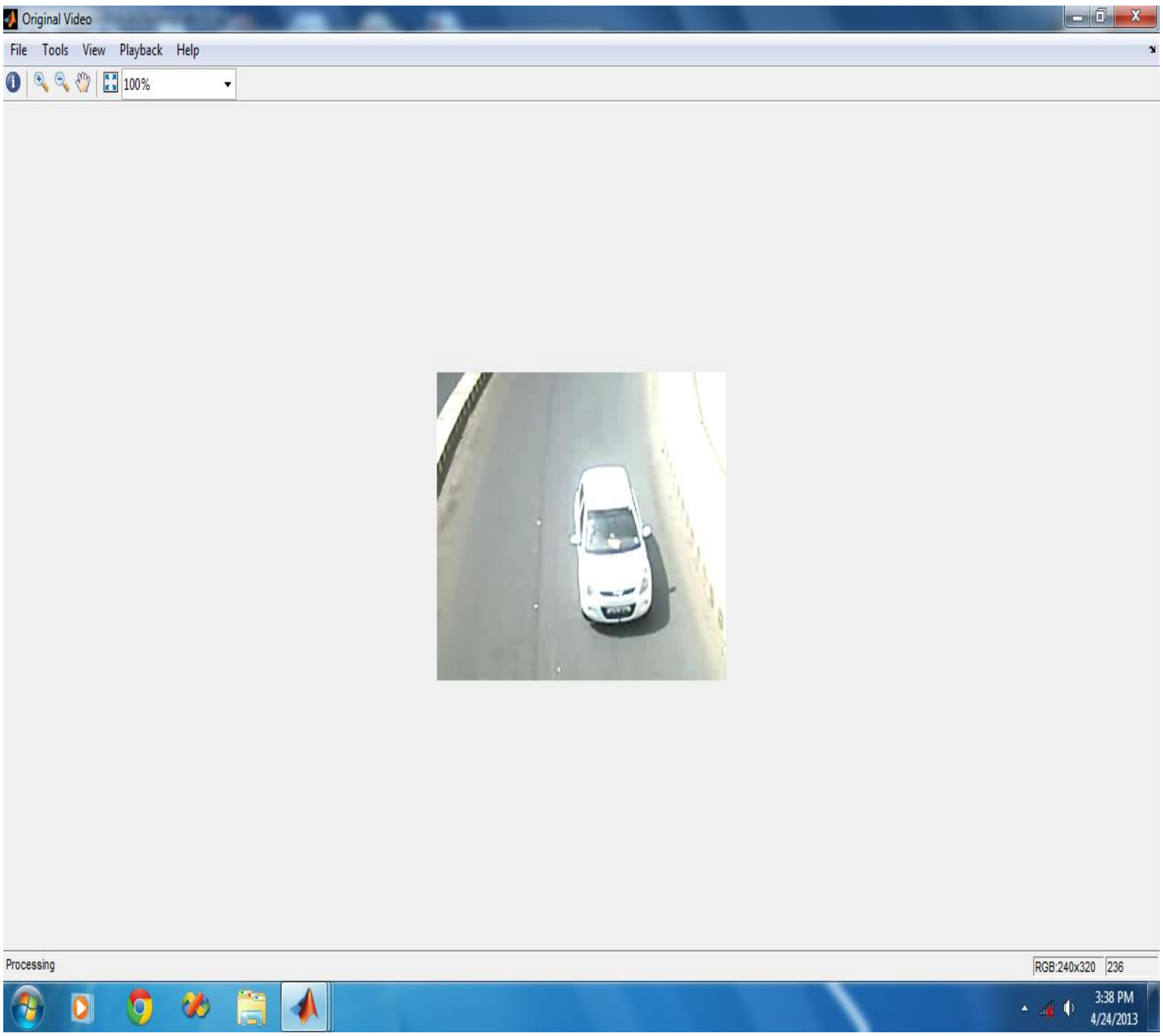


**Figure 5.2: FOREGROUND RESULT**

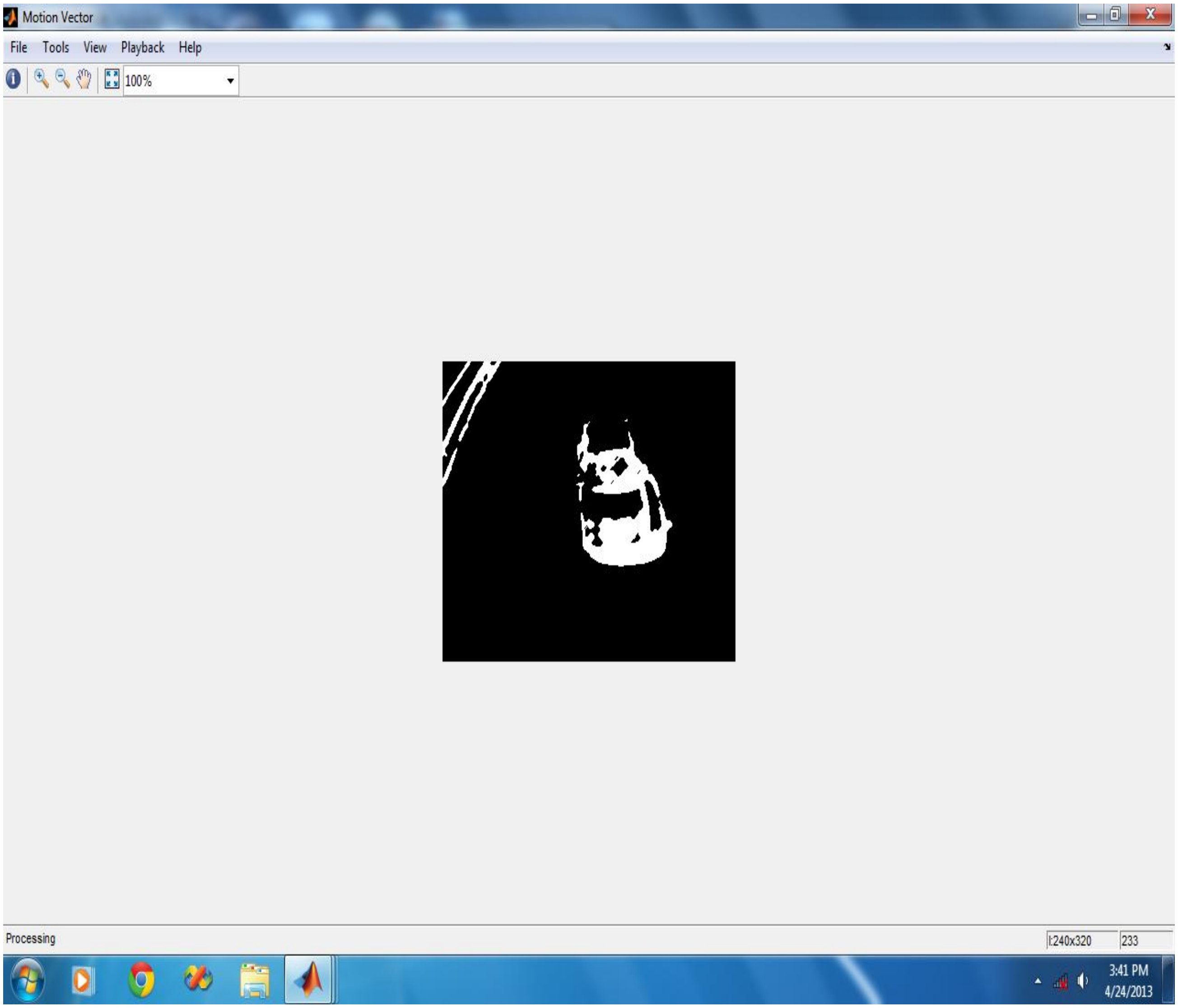


**Figure 5.3: DETECTED VEHICLES**

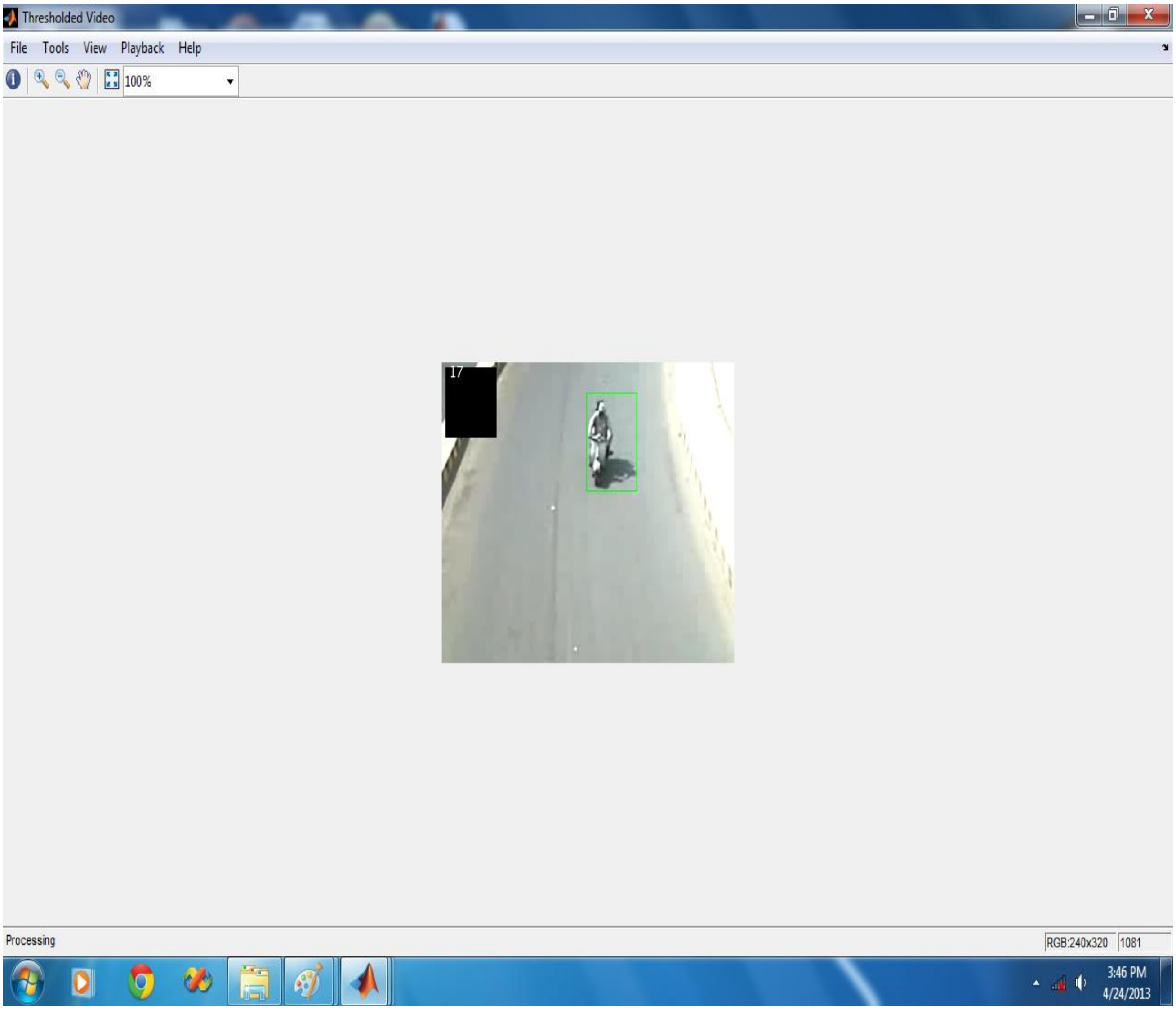


**Figure 5.4: COUNTING VEHICLES**

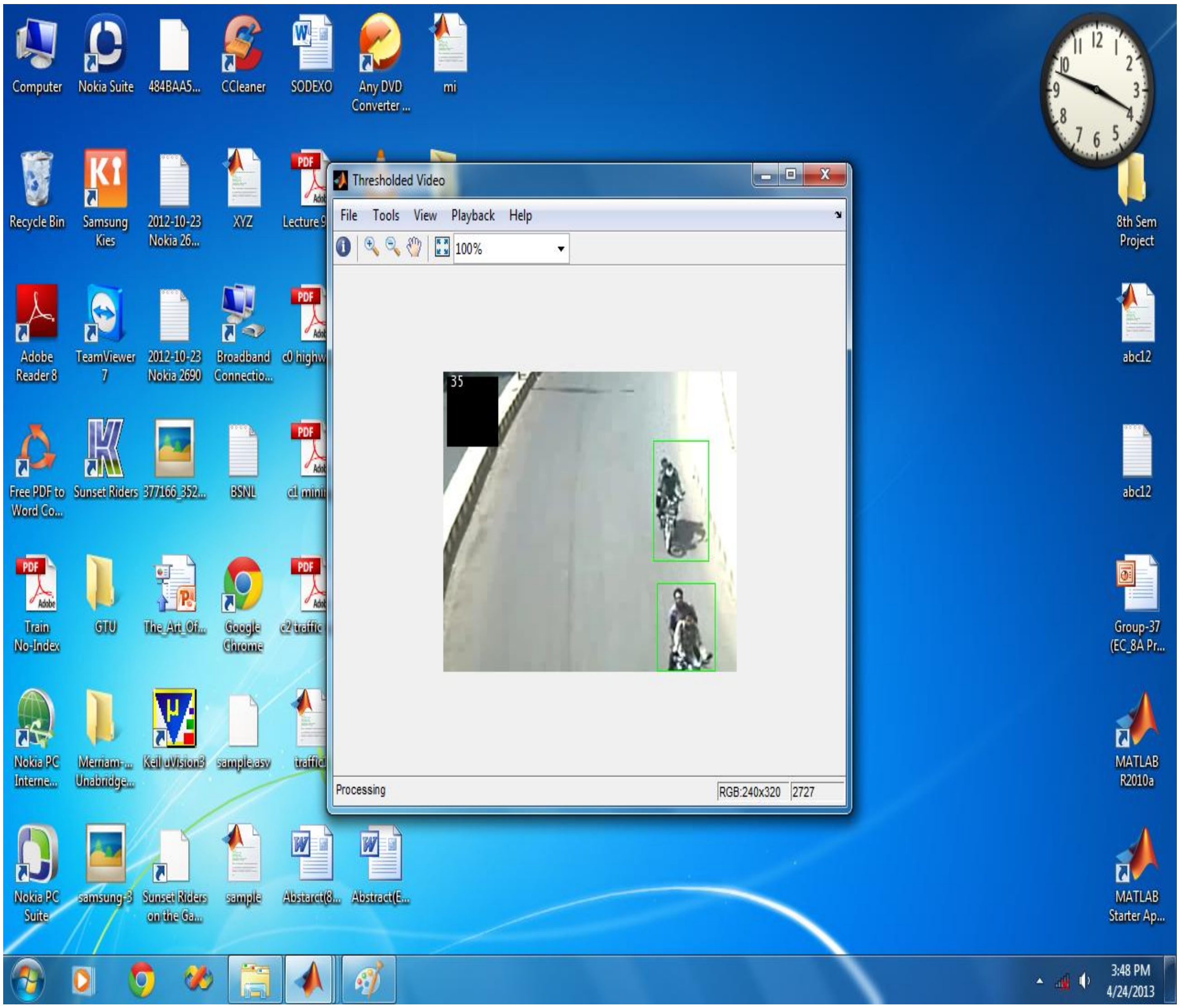
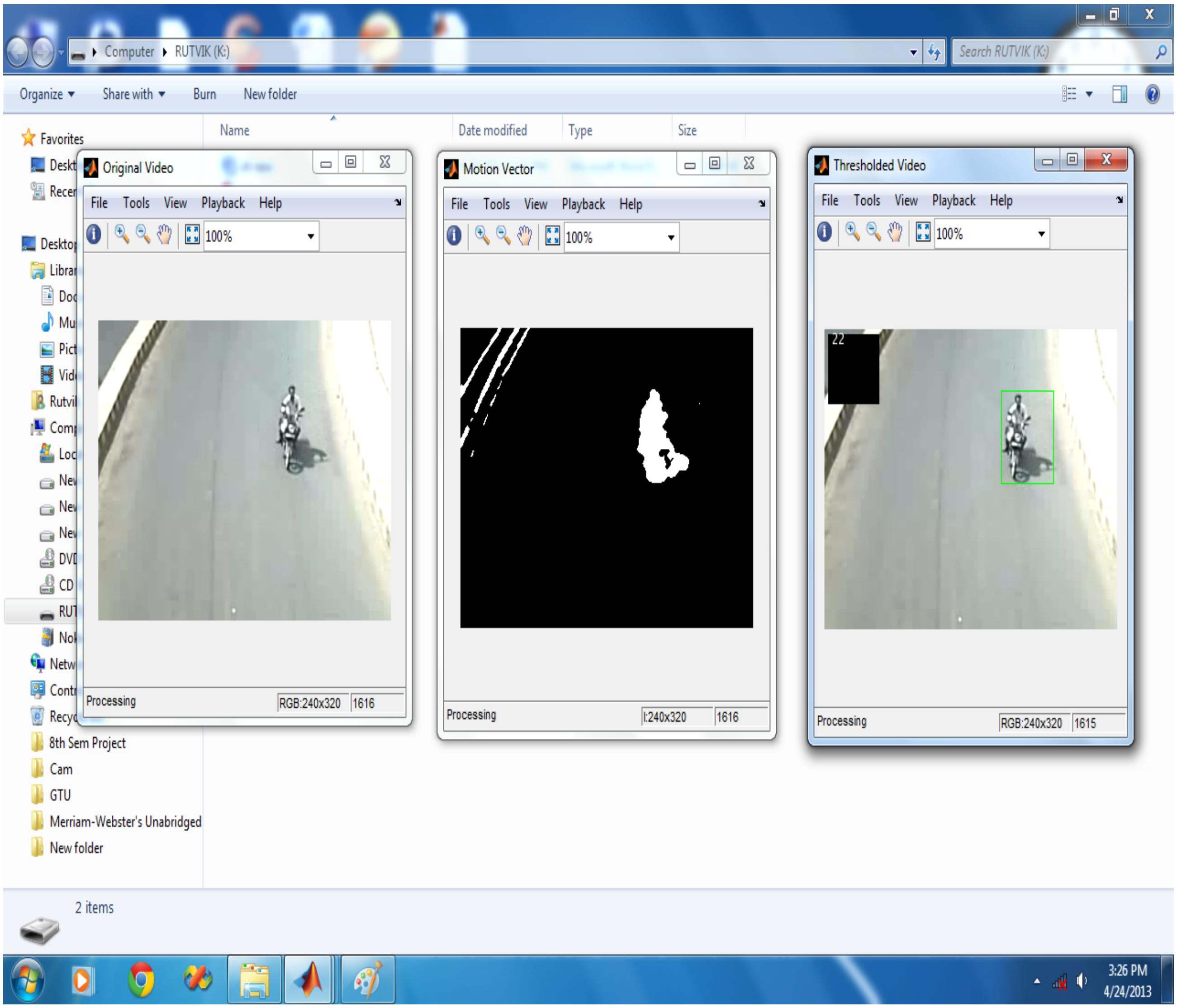


**Figure 5.5: COMBINED RESULTS**



## Figure 5.6: ORIGINAL VIDEO, THRESHOLDED IMAGE AND RESULTS

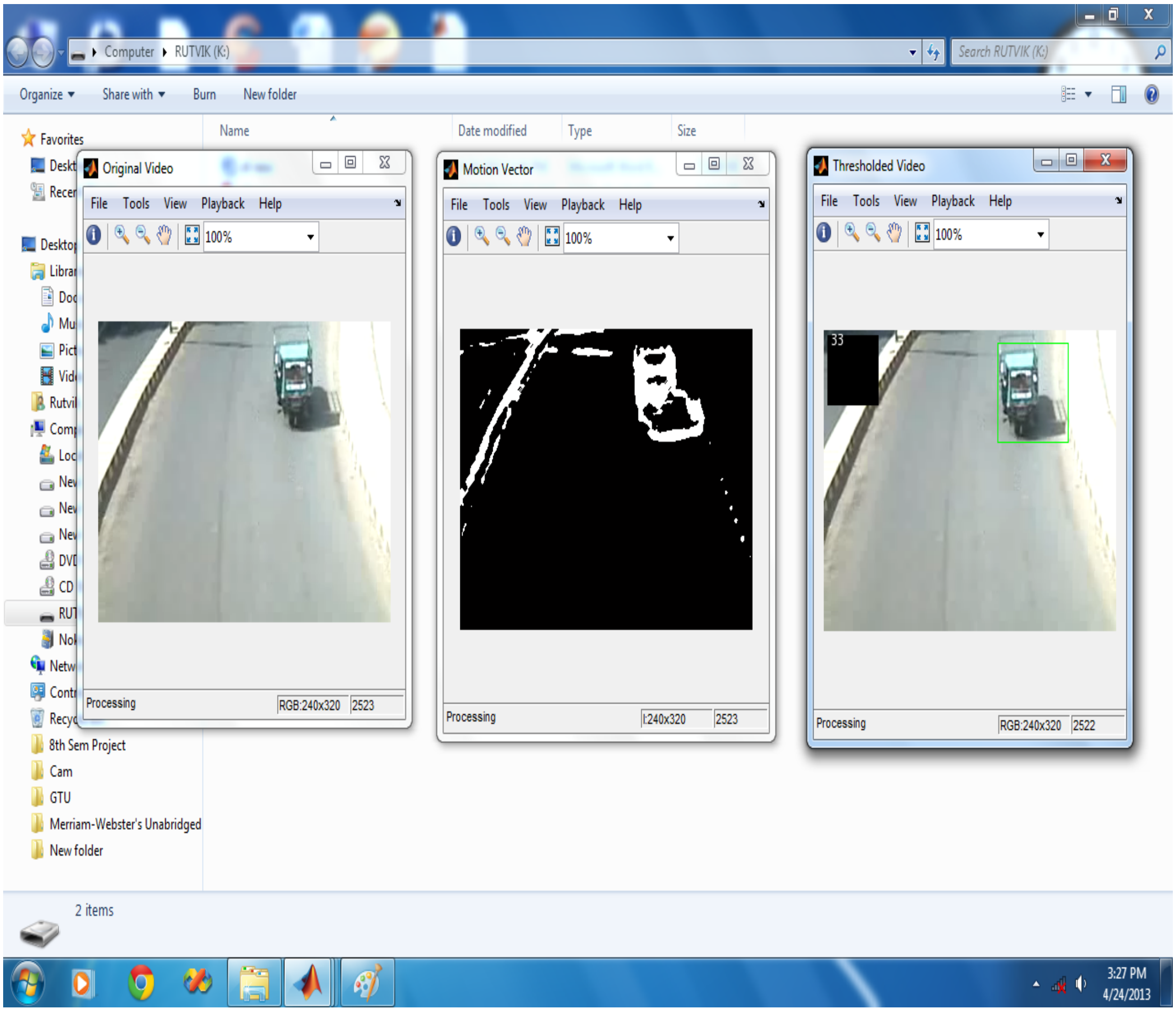
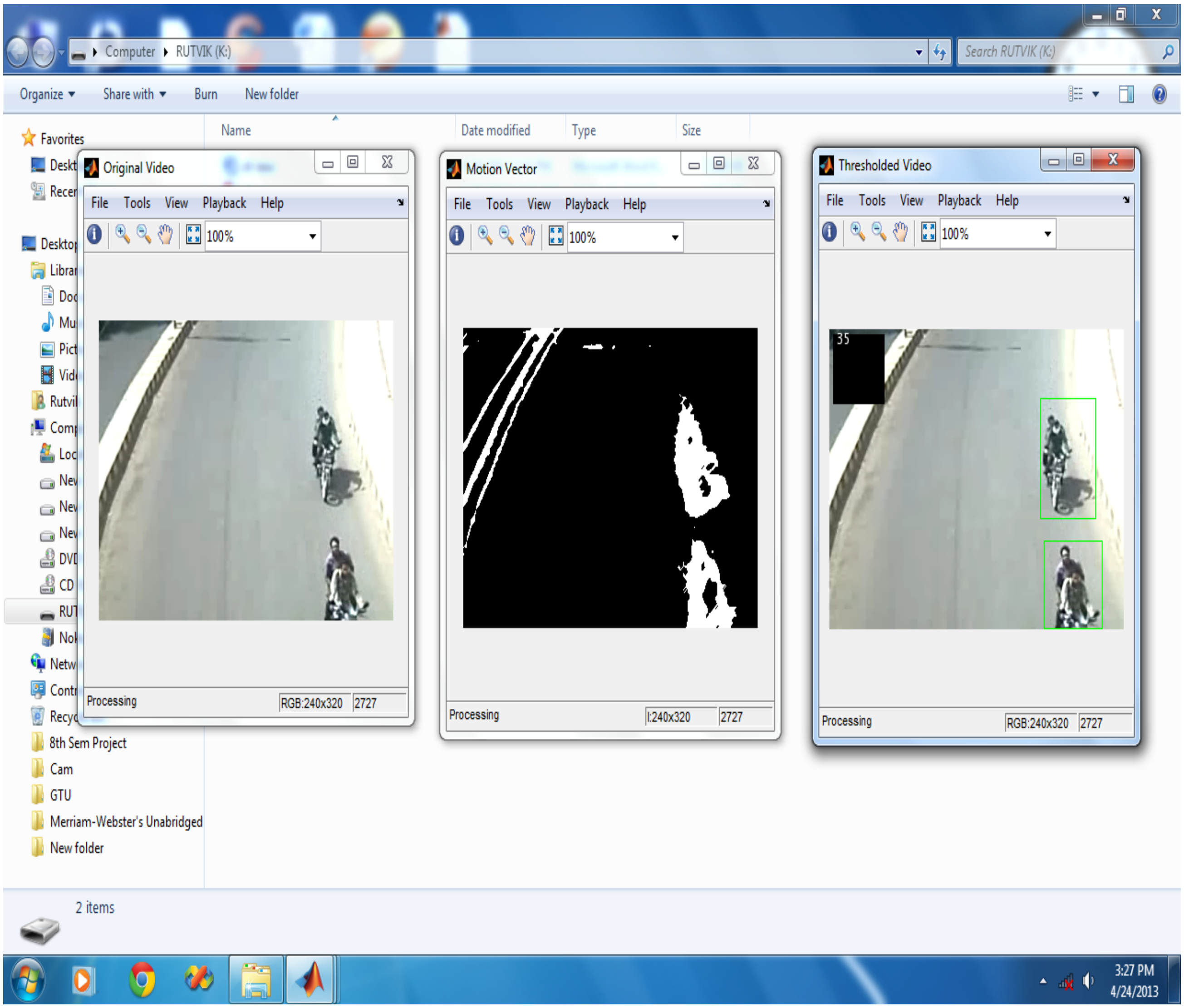


**Figure 5.7: Vehicle counting**



# Chapter 6

# APPLICATIONS

## 1. TO AVOID TRAFFIC CONGESTION

- In recent year, as a result of the increase in vehicle traffic, many problems have appeared. For example, traffic accidents, traffic congestion, traffic induced air pollution and so on. Traffic congestion has been a significantly challenging problem. It has widely been realized that increases of preliminary transportation infrastructure e.g., more pavements, and widened road, have not been able to relieve city congestion. As a result, many investigators have paid their attentions on intelligent transportation system (ITS), such as predict the traffic flow on the basis of monitoring the activities at traffic intersections for detecting congestions.
- To better understand traffic flow, an increasing reliance on traffic surveillance is in a need for better vehicle detection such at a wide-area. Automatic detecting vehicles in video surveillance data is a very challenging problem in computer vision with important practical applications, such as traffic analysis and security. So this software helps in overcoming such traffic congestion problems.

## 2. SIGNALING FOR SMOOTH TRAFFIC FLOW:

- Video surveillance system helps in signaling traffic. For example, consider a scenario when there is a low traffic on the road, then the traffic signal is ON for a high time and if traffic is very high, then signal will be ON for short time. So, using this algorithm, we can manage very smooth and secure traffic on any road in any city.

**3. DIVERTING THE TRAFFIC:**

- This algorithm counts number of vehicles on each and every road. Now suppose if any road has very high traffic, and any alternate road has low traffic, then we can display the message regarding traffic intensity on the alternate road. So, with the help of this above system, we can effectively and efficiently divert heavy traffic to reduce congestion for the better development of country.

**4. POWER SAVING**

- In recent year, the number of electronics hoardings, signs and boards increase rapidly day by day, for advertising different advertisements on highways particularly. Sometimes, all these boards remain on unnecessarily for whole night, requiring lots of electricity. Thus, using this autonomous system, based on intensity of vehicles, we can manage regulation of providing electricity to boards. Thus, with the help of this efficient software, we can contribute to the nation by saving the power.

**5. SURVEYING**

- Building bridges are essential in metropolitan areas to avoid congestion. In these days, it requires surveys for building bridges, are carried out by mankind itself. So, based on the database recorded by our project, it helps us in surveying, regarding where to construct bridges, roads or flyovers. So, this helps to reduce work and labor of mankind.

# Chapter 7

# Future scope for expansion

- The computer vision and image processing can be applied in many aspects for the traffic parameter extraction (Vehicle counting, speed measurement etc). So far, we succeeded to get the number of vehicle, the accuracy of the result can be further improved by some good background extraction, now vehicle occlusion and shadows are problem for getting the correct value.

- Currently the application is working in a standalone system, if we implement this application to multiple locations in the town using web application then the data can be further used for traffic controlling and planning.

- The vehicle detection in the proposed system is robust in variant weather conditions, we can do experiment in night also. We can find and implement other methods to help us find vehicles at night.

- The system can be implemented on roads, highways, having mounted camera, capturing videos and control room continuously getting vehicle counts, so necessary measures can be taken sitting at control room itself.

- In future work, more vehicle outline features and additional cases will be considered to increase the recognition rate.

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