ABDULGADER RAMADAN GADAH

VEHICLE SPEED MEASUREMENT USING IMAGE PROCESSING

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A THESIS SUBMITTED TO THEGRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By
ABDULGADER RAMADAN GADAH

In Partial Fulfillment of the Requirements for the Degree of Master of Science in Electrical and Electronic Engineering

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Approval of Director of Graduate School of Applied Sciences

Prof. Dr. Nadire ÇAVUŞ

We certify this thesis is satisfactory for the award of the degree of Master of Science in Electrical and Electronic Engineering

Examining Committee in Charge:

Assist.Prof. Dr	Committee Chairman, Department of
Assist.Prof.Dr.	Department of
Assist.Prof.Dr	Department of

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Abdulgader Ramadan Gadah

Signature:

Date:

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First and foremost, I would like to begin by thanking my family and parents for their support. Four semesters passed; I had some good days and other hard days, whenever I was down, they were giving me the hope and strength to continue.

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To my family…

ABSTRACT

In this thesis, I propose the use of video image processing for video processing real time detection of vehicles speed. It aims to segment vehicles in a video and detect its speed in real time movements. The work consists of many stages until the calculation of vehicles speeds where it detects the speed of cars while they are moving.

At first, the video is captured and the first frame is considered as a reference image so that it will be later used for distance measurement. Secondly, the videos or the frames are segmented (binarized) and the vehicles are detected. Then, continuously, and using the saved reference image, the distance of each new frame is measured and based on the value of it the speed is calculated. The speed is calculated based on the distance and time of the vehicle in a specific frame.

Finally, the speed is set to 3 bands based on their value: slow, medium, and fast. The system shows the value of the speed of the vehicle as it moves, as well as take a picture of the vehicle that exceeds the preset speed limit and stored in folder can be referred to.

Keywords: image processing; thresholding implementation; edge detection; background subtraction; tracking moving objects.

ÖZET

Bu tez çalışmasında, video işlemede kullanılan araçların hızını gerçek zamanlı olarak tanıyan bir video görüntü işlemcisinin kullanılmasını öneriyoruz. Videotape'deki araçları segmental ayırmayı ve gerçek zamanlı hareketlerde hızlarını belirlemeyi amaçlıyor. Taşıtlar, hareket halindeyken aracın hızının tespit edildiği araçların hızının hesaplanmasından itibaren birçok aşamadan oluşur. İlk önce, video okunur ve ilk okuma çerçevesi referans görüntü olarak kaydedilir, böylece daha sonra mesafe ölçümü için kullanılır.

İkincisi, videolar veya okuma çerçeveleri bölümlere ayrılır (ikili olarak) ve Araçlar tespit edilir. Ardından, sürekli olarak ve kaydedilen referans görüntüsünü kullanarak, her yeni çerçevenin uzaklığı ölçülür ve hız hesaplanır. Hız, belirli bir karede aracın mesafesine ve süresine göre hesaplanır.

Son olarak, hız, değerlerine göre 3 gruba ayarlanır: orta, yavaş ve hızlı. Program, hareket halindeyken aracın hızının değerini gösterirken, limit hızını aşan ve resimdeki araçta saklanan aracın resmini çekebilir.

Anahtar Kelimeler: görüntü işleme; eşikleme uygulaması; Kenar algılama; arka plan çıkarma; hareketli nesnelerin izlenmesi.

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LIST OF ABBREVIATIONS

FFT:	Fast Fourier Transforms
ORBIS:	Offering Rail Better Information Services
RGB:	Red Green Blue
SDCS:	Speed Detection Camera System

CHAPTER 1
INTRODUCTION

1.1 Introduction

One of the devices that has been created to record the cars speed is “ORBIS” which is an automatic speed violation control device the device depends on systems that are using loop coil or “radar“, but this kind of devices that depends on the loop coil technology has it’s drawn backs, it has a high installment costs, and high maintains costs, furthermore it may faces a miss detection in many cases.

The advancement of the technology allowed the use of new methods in the devices that are used to record the car speed, such technologies is image processing approach, this kind of technology record a photo log for the cars, and keep records of accidents in case of occurrence, as long as data about the vehicles involved in the accident such as the vehicle speed, the vehicle licenses plate number, and the time of the accident (Pornpanomchai & Kongkittisan, 2009).

The continuous increase of population; especially in main cities and capitals, lead to congestion problems and accidents. This issue is becoming a major concern to governments and transportation engineers. Traffic management techniques today are no more adequate regarding cost and performance. According to Roland Berger studies, traffic congestion in the world’s 30 biggest cities generates an annual cost of more than 266 billion dollars (Szottka & Butenuth, 2011). Moreover, the Lebanese government in cooperation with Harvard University and Louisiana University prepared a study about annual costs due to traffic congestion which is estimated of about 2 billion dollars. These costs not only include the time wasted in traffic jam, but also excess fuel consumptions and vehicles maintenance. Another study by Urban Mobility Report estimated that traffic congestion for the 75 U.S (Pornpanomchai & Kongkittisan, 2009). Urban areas generate annual cost of 89.6 billion dollars in which the value of 6.9 billion gallons of excess fuel consumed and 4.5 billion hours of delay (Kerekes, Muldowney, Strackerjan, Smith, & Leahy, 2006).

Due to the previous mentioned reasons and statistics, there is a need to change the traffic management system. An intelligent traffic control system that can continuously sense the actual traffic load in intersections and thus can adjust the timing of traffic lights. Building this intelligent traffic light control system can result in the reduction of traffic congestions at intersections, reduce annual costs that include time wasting, system maintenance and fuel consumptions; moreover, less environmental pollution; furthermore, increase the capacity of infrastructure.

Many techniques have been used for controlling traffic at junctions including, manual control, time controlled traffic lights, microwave and laser radars, and ultrasonic sensors (Szottka & Butenuth, 2011). These techniques are affected by road and weather conditions and thus results low efficient control of traffic flow. Consequently, it is becoming very critical to implement efficient, economical, and adaptive traffic control system that can guarantee smooth traffic flow at junctions.

Digital image processing is now widely popular and growing field where its used in medicine, military, video production, security, tracking objects, and remote sensing (Huiyu Zhou, Jiahua Wu, 2010b). The aim of this study is to design an intelligent traffic control system which will control traffic lights based on image processing. The system can measure the traffic density at each junction and accordingly change the time delays where the traffic density is greater.

Generally, the examination of moving objects, regardless of whether they are fire fronts, particles, beads, or liquid interfaces, was done physically, more often than not by measuring elements of a picture anticipated on a divider. This manual investigation was dreary and experienced numerous inadequacies, including poor precision and poor repeatability. The smoothness and impression of the divider or projection screen was an issue, similar to the strength of the projector and the poor lighting conditions. Since every one of the estimations were performed by hand and by eye, repeatability was dependably.

The moving objects following in video pictures has pulled in a lot of enthusiasm for PC vision. For protest acknowledgment, route frameworks and reconnaissance frameworks, question following is an irreplaceable initial step. Question following has centrality continuously condition since it empowers a few essential applications. For example, security and observation to perceive individuals, to give better conviction that all is good utilizing visual data. In restorative treatment to enhance the personal satisfaction for non-intrusive treatment patients and debilitated individuals. In retail space instrumentation to break down shopping conduct of clients to upgrade building and condition outline, video deliberation to acquire programmed explanation of recordings, to create protest based synopses, activity administration to dissect stream, to distinguish mishaps, video altering to dispense with awkward human administrator association, to plan advanced video impacts.

The shading picture preparing and protest following framework (Following Framework) was intended to beat these lacks. It was intended to be completely programmed, in this way expelling a portion of the mystery from the investigation and also diminishing the repetitiveness of examining an extensive number of edges. Since the picture is changed over to computerized organize, it can be handled carefully, enhancing the picture and empowering less demanding discovery of edges. Now and again it might be ideal for the client to find the question physically with a mouse as opposed to have the PC do it. The following framework permits this. The greater part of the picture handling that can be performed in the programmed following mode can in any case be performed in the manual mode, at the client's carefulness. A few following strategies (or modes) hatchet executed. A layout coordinating strategy can be utilized as a substitute to the robotized limit based technique. The layout coordinating strategies, including connection and a subtractive method, track picture highlights as opposed to edges. A locale parameters technique can track development of force based parameters, for example, power most extreme, least, and mean, in a chose stationary area. The last following strategy right now actualized is the territory estimation technique, which can be utilized measure scaled or nonsealed regions.

Question following in a mind boggling condition has for some time been an intriguing and testing issue (Yilmaz, Javed, & Shah, 2006). In the remote detecting setting, it has frequently been connected to the utilization of aeronautical or satellite symbolism to track ground vehicle movement (Hinz, Weihing, Suchandt, & Bamler, 2008). Calculations have been created to show vehicle following utilizing low-rate video or unmistakable symbolism groupings gathered by sensors on airplane (Szottka & Butenuth, 2011).

Airborne ghastly symbolism (Kerekes et al., 2006) and in addition phantom joined with polarimetric imaging (Presnar, Raisanen, Pogorzala, Kerekes, & Rice, 2010) have additionally been utilized to show the ability of remote detecting stages to track vehicles. In another application, satellite symbolism (Liu, Peng, & Chang, 1997) alongside other information sources (Bruno et al., 2010) have been utilized to track sends in the sea. Moreover, manufactured gap radar airborne and satellite sensors have likewise been appeared to have surface question following capacities (Hinz et al., 2008).

1.2 Literature Review

This technology has its flaws, for instance in situations of the absence of light the device may not be fully able to record accurate data about the vehicle speed, and the photo log that will be saved will most likely by blurry (Goda, Zhang, & Serikawa, 2014).

One of the solutions that are suggested to overcome the dark situations in the image processing technology is using the headlight of the car while it’s moving .By default the system will take a picture for any moving object, in this case the moving object will be the car, the picture will be taken depending on the shutter speed which depended on the environment that is surrounding the car, since the environment is dark the first object that will be detected by the camera is the car headlights.

Since the car is moving, and the camera is fixed the car headlights will be recorded as a light line, in the second step the image will be processed, and the light line will be extracted from the picture, in the third step the system will project a transformation against an optional area from the road, this process will calculate the length of the light line but first in order for the system to work a distance of the an optional road area must be known. Using the previously known length and the shutter speed the car speed can be determined .The advantages of this system is its low costs, and its ability to substitute the speed gun which depended on the radar technology, and needs an expert to use it.

The steps can be ordered as following:

- Camera installment.
- Taking the length of an optional area from the road.
- Determining the shutter speed.
- Entering data related to the measurement area.
- Take a picture of the moving car.
- Process the image, and take out the light line from the picture that is created by the moving car headlights, and the fixed camera.
- Calculate the length of the line and the shutter speed that will gave us the car speed.

The processing of light line extraction is as follows:

- step.1 Input of the image.
- step.2 the weighted average histogram will be calculated.
- step.3 threshold decision.
- step.4 Mask process by the threshold.
- step.5 Projective transformation.
- step.6 Labeling processing.
- step.7 the real distance of the light line will be calculated.

All the previous devices, and technologies are categorized under traffic surveillance systems which has a purpose of forcing vehicles to stay within the road speed limits under the threat of paying fain if they don't, this systems are responsible for giving indexes about traffic parameter like the number of vehicles on the road, the vehicle speed, and traffic congestion, and as we mentioned earlier speed is the main cause of accidents, so most researches concerning this field are dedicated to record the speed of the vehicles, also as we mentioned earlier image processing technology is one of the most promising technologies concerning the traffic monitoring field.

The radar technology is an old technology, and it is useable for traffic monitoring purposes, this technology was mainly developed for military purposes, but it can be used for civilian purposes nevertheless this technology is highly costly, and less accurate than the image processing technology (Kerekes et al., 2006).

The image processing technology is widely used in video surveillance systems, but it also can be applied for traffic monitoring purposes, by tracking moving objects in the video sequence, in the video sequence the moving objects will be cars, so the image processing technology will extract trajectories from the video, and will be able to find traffic intensity, and estimate vehicle velocity.

Please note that the threshold decision is very important, and necessary, and some areas that had light in the picture will take out from the image within this threshold, the light line will be included in the lights areas previously mentioned, then projective transformation on the optional area will be performed, and lastly to pick up the light line from these (Goda et al., 2014).

CHAPTER 2
IMAGE PROCESSING

2.1 Introduction to Image Processing

The essential concept of image handling indicate to preparing of computerized image, became empty the clamor and with any classify of abnormalities sitting in a image use the advanced computer. The excitement or exceptionmustcreepin the imageeach center its adjustment or centermodificate and still on. For scientific examination, a image can bedescribe as a two-dimensional assimilationf(x,y) with x and y are locative (plane) facilitates, and the adequacy of at any match of capacity (x, y) is recognized as the power or deepscale of the picture by then. Whenever x, y, and its power assessment of f are all limited, separatedcontain, we call the image a computerized image. It is critical that an advanced image that is synthetic out of a limited number of strain, each of it has a particular area and esteem. These strain are called imagestrain, and pixels. Pixel is the extreme broadly utilized term to subserve the components of a computerized picture.

Various systems have been created in Picture Handling amid the final four to five contract. The greater part of the strategies are formed for upgrading pictures gotten from unamedprojectile, storage tests and military supervisionaviation. Picture Handling structure are obtained to be plainly prevalent n order to simplify theconductivity of dynamicwork forcing the PCs, comprehensivethe volumeof storetool, representation propagation and so forth.

Current computerized invention has creat it potential to lead multi-dimensional mark with frame that zone from basic advanced loop to harvesttheborder parallel of PCs. The goal of this observation can be separated in three classes: • Image Handling image in → picture out • Picture Examination image in → assessment out • Picture Understanding image in → annormal state depiction out it will crowd on the principal ideas of image preparing. area does not permit us to create more than a pair of early on comments about imageinspection. image understanding requires an approach that contrasts on a very basic level from the subject of this record. Promote, it will limit itselves to two–dimensional (2D) image preparing albeit the greater part of the concept and procedures that are to be recorded can be prolonged out operative to at least three measurements.

It is starting with certain primarysimplification. An imagedescribe in "this present reality" is concept to be a component of two actual factors, for model, a(x,y) plus the adequacy (e.g. splendor) of the picture at the true organize placement (x,y). A imageable to be reflected to include sub-pictures now and then suggested to as regions– of–interest, returns on initial capital investment, or onlyareas. This concept mirrors the road that images oftentimes implicatecollections of articles each one of it can be the cause for a space. In a reduplicateimage handling frame it should to be possible to stratifyspecificimage preparing process to chose part. Therefore one a agent in a image (area) able to be handled to smother movement inglorious while another pieceable to be prepared to promotetent version. The amplitudes of a given picture will quite often be either genuine numbers or whole number numbers. The last is generally a consequence of a quantization procedure that changes over a persistent territory (say, in the vicinity of 0 and 100%) to a discrete number of levels. In certain picture shaping procedures, notwithstanding, the flag may include photon numbering which infers that the abundancy would be characteristically quantized. In other picture shaping techniques, for example, attractive reverberation imaging, the direct physical estimation yields a mind boggling number as a genuine extent and a genuine stage. For the rest of this book we will consider amplitudes as reals or whole numbers unless generally demonstrated.

2.2 Digital Image Processing

Image processing is a mode used to promote frank images received from medical and military applications, satellites, and security cameras. The image is processed and analyzed using several techniques like image enhancement which include brightening, sharpening edge enhancement, etc. Majority of image processing techniques treating with two-dimensional images. Image processing is indicative processing where the input is a picture or video frames and the output is an picture or parameters related to it.

Picture increase is the process of beneficent the type of digital images so that it can be interpreted by human or computers. Image enhancement includes many algorithms such as filtering, extraction, correlation, and time compression. There are mainly two methods for image enhancement: first one deals with image in frequency domain and the other one deals with image in spatial domain. The frequency domain is based on Fourier series transformation and the other one is based on processing of individual pixels of the image.

In inferior inequality image, the relative characters combine pending binarization. It will use Power-Law Transformation to reduce the spread of characters before thresholding which raise the disparity of particle and support in preferable image segmentation. The Power-Law Transformation equation is given by $s = cr^{\gamma}$, which r and s are respectively the input and output density, c and γ are positive. The indicator in the power-law equation (γ) is indicate to as gamma correction.

The MATLAB stands for Matrix Laboratory. It was written primarily to supply simple entrance to matrix software created and advanced by the LINPACK (linear system package) and with the EISPACK (Eigen system package) planner. The program has been commercially obtainable since 1984 and is now applied widely in most universities applications. MATLAB is a high-execution and advanced parlance for solving artistic calculating issues. MATLAB has a progressing data structure, include built-in marking, simulation, and debugging stuffs which make him as excellent programming software for teaching and research purposes.

Computerized picture preparing is the innovation of applying various PC calculations to handle advanced pictures. Results of this procedure can be either pictures or an arrangement of agent qualities or properties of the first pictures. Utilizations of advanced picture preparing have been ordinarily found in mechanical autonomy/astute frameworks, therapeutic imaging, remote detecting, photography and criminology (Huiyu Zhou, Jiahua Wu, 2010a).

Flag handling is a teach in electrical designing and in science that arrangements with examination and preparing of simple and computerized signals, and manages putting away, separating, and different operations on signs. These signs incorporate transmission signals, sound or voice signals, picture signals, and different signs etc.

Out of every one of these signs, the field that arrangements with the kind of signs for which the information is a picture and the yield is additionally a picture is done in picture preparing. As it name proposes, it manages the handling on pictures.

It can be additionally isolated into simple picture handling and advanced picture preparing.

The expression digital image processing mostlyindicates to transformation of a couple-dimensional image by a digital PC. In a floppycondition, it suggests digital processing of any couple-dimensional data. A digital image is adisposition of true numbers demonstrated by a limited number of sting. The standardfeature of Digital Image Processing procedures is its variation, repeatability and the conservation of original data accuracy. The different Image Processing techniques are:

- Image segmentation
- Image restoration
- Image recognition
- Image classification
- Image enhancement

2.2.1 Image segmentation

Division is one of the opener issues in picture handling. A well-known technique utilized for picture division is thresholding. After thresholding, a paired picture is shaped where all protest pixels had only one dim scale with all foundation pixels take added - by and large the question pixels are "dark" and the foundation is 'candid '. The preferable edge is the one that chooses all the protest pixels and charts them to 'dark'. Different methodologies for the programmed choice of the limit have been suggested. Starting able to be characterized as charting of the dark scale in the double set {0, 1}:

$$S(x,y) = \begin{cases} 0 \text{ if } g(x,y) < T(x,y) \\ 1 \text{ if } g(x,y) \geq T(x,y) \end{cases} \quad (2.1)$$

Which S(x, y) is the estimation of the portioned picture, g(x, y) is the dim scale of the pixel (x, y) and T(x, y) is the limit an incentive at the directions (x, y). In the least difficult state T (x, y) is facilitate free and a consistent for the entire picture. It can be chosen, for example, on the premise of the dim scale histogram. At the point when the histogram has a pair of articulated maxima, which contemplate dark scales of theme (s) and foundation, it is conceivable to choose a solitary limit for the whole picture.

A technique which depends on this thought and uses a relationship foundation to choose the best edge, is portrayed underneath. Occasionally dark level histograms have just a single greatest. This must be brought on, e.g., by inhomogeneous light of different areas of the picture. In this situation, it is difficult to choose a solitary verge esteem for the whole picture and a neighborhood banalization method (portrayed beneath) have be connected. Universal strategies to take care of the issue of banalization of in homogeneously lit up pictures, be that as it may, are not accessible.

Division of pictures includes once in a while not just the segregation amongst items and the foundation, additionally partition between various districts. The issues of picture division and gathering stay extraordinary difficulties for PC vision. Since the season of the Gestalt development in brain research (B. & Wertheimer, 1938), it has been realized that perceptual gathering assumes a capable part in human visual per-1 caption. An extensive variety of computational vision issues could on a basic level make great utilization of fragmented pictures, were such divisions dependably and effectively calculable. For example, middle level vision issues, for example, stereo and movement estimation require a fitting district of support for correspondence operations. Spatially non-uniform districts of support can be distinguished utilizing division procedures. More elevated amount issues, for example, acknowledgment and picture ordering can likewise make utilization of division brings about coordinating, to address issues, for example, Figure-ground detachment and acknowledgment by parts.

While the previous couple of years have seen extensive improvement in eigenvector-based strategies for picture division (Weiss, 1999), these techniques are too ease back to be in any way functional for some applications. Interestingly, the strategy portrayed in this paper has been utilized as a part of extensive scale picture database applications as depicted in (Cornel S. Pintea, 2012). While there are different ways to deal with picture division that are very productive, these techniques by and large neglect to catch perceptually critical non-neighborhood properties of a picture as talked about beneath. The division method created here both catches certain perceptually essential non-neighborhood picture qualities and is computationally 2 effectives – running in O (n log n) time for n picture pixels and with low consistent variables, and can keep running practically speaking at video rates.

2.2.1.1 Global thresholding using a correlation criterion

Regarding the verge trouble, lease *g* symbolizes the potential leaden amount in the main picture. Those amounts are described by the beneath- and above-verge instrumentation $\mu_0(T)$&$\mu_1(T)$of the main picture, presented with:

$$\mu_0(T) = \sum_{g=0}^{T} gp_g\left(\sum_{g=0}^{T} p_g\right)^{-1} \tag{2.2}$$

Which g = 0, 1, ...,n all gray amounts with T (0 <T <n) is the verge scale. The eventuality compilation *pg* of gray amounts *g* is assumed by *p f N g g*= wherever *N* is the full amount of pixels in the picture and *f g* is the amount of pixels processing gray amount *g*.

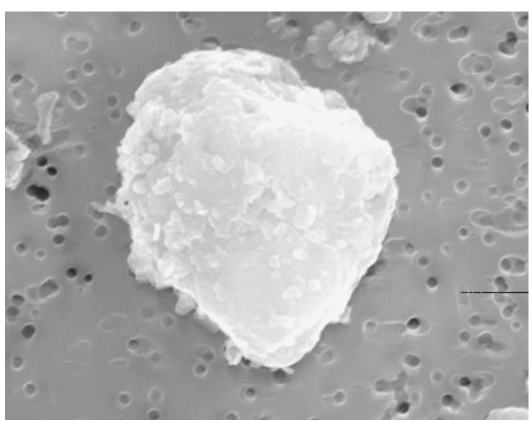


Figure 2.1: The producer of stratify the connection standard setup

The difference represented by

$$V_x = E_{xx} - (E_x)^2, V_y(T) = E_{yy}(T) - \left(E_y(T)\right)^2 \qquad (2.3)$$

Actually, E_x, E_{xx} &V_x are separated of the verge T that they are acquired from the main image. The connection degree given by:

$$P_{xy}(T) = \frac{E_{xy}(T) - E_x E_y(T)}{\sqrt{V_x V_y(T)}} \qquad (2.4)$$

It is today a task from the verge scale. That optimum amount of T coincides to the amount that make the most of the connection through the true and the second amount pictures. This amount is set up by repetition. The effect of stratifying the mechanism to a subordinate electron SEM picture of a civilian powder character. As visible from the model, the connection procedure elected a significate verge.

2.2.1.2 Local binarization using discrete convolution

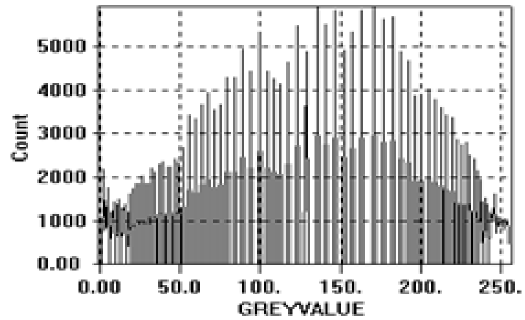
This mode of binarization is established on the implementation of the separated complication refinement mechanism that create a changed picture that is able to be simple threshold using 1 as the verge amount.

For resolution creating near a proper mathematical amount of stricture p, the grade of connection among the main and the involutes pictures is applied. It is elaborated as tracks:

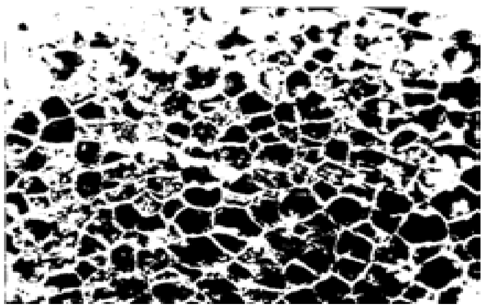
$$r(p) = \frac{Cov(f, g(p))}{\sqrt{Var.Var(g(p))}} \qquad (2.5)$$

Which f and $g(p)$ are the main gray scale image and the image involutes by means of amount for the limit, correspondingly.

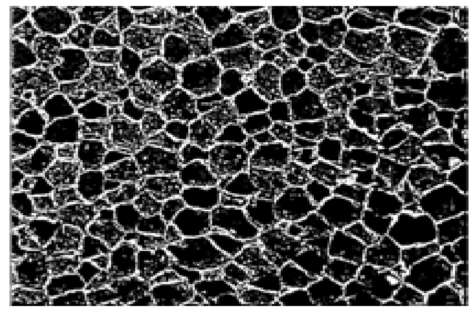
(a) Original picture



b) Gray level histogram



(c) Global thresholding



b) Local thresholding

Figure 2.2: The 4 steps to the image banalization

2.2.1.3 Segmentation based on watershed transform

The technique for division in view of the utilization of borderer stripes was created in the system of scientific morphology. Look a picture f which is a topographic roof, characterize the catchment bowls and borderer crosses as far as a contracting procedure. Envision that every bore of the roof is punctured which have a surface is dove in a mere with a consistent straight speed. This water step inside that openings surges of the roof. The minute that the surges stuffing two particular catchment bowls begin to combine, a barrage is raised with a specific end goal to forestall blending of the surges. The association of all barrages characterizes the watershed stripes of the picture f. There are distinctive PC executions of watershed calculations. Fundamentally, they are able to be partitioned in two gatherings: calculations, which reproduce the overwhelming procedure and strategies going for immediate location of the watershed focuses.

2.2.1.4 Edge detection techniques

Edge detection is an essential tool for image segmentation. It reduces the quantity of data to be processed; however it preserves image information regarding the shapes in it. There are many edge detection techniques used in image processing. The most commonly used are listed below.

Edge detection is a set of mathematical methods which aim to produce something like a line drawing of a digital image. The lines in the new image are formed due to sharp difference in image intensity levels. For example, different objects in the image with different colors cause intensity level differences as we move from object to other and from color to other. Moreover, light distribution on image surface also causes changes in intensity levels.

Figure 2.3: Original image before edge detection(Kaur & Singh, 2016)

Figure 2.4: Resulting image after edge detection(Kaur & Singh, 2016)

2.2.1.4.1 Roberts edge detection

According to (Roberts, 1965), the Roberts operator implements easy, fast to calculate, 2-D locative inclination calculation on an image. It is thus important areas of a rising locative gradient which often coincide to borders.

In judgment, the technique includes of a couple of 2×2 gyration covers as shown in Figure First visor is easy the different alternate by 90°.

The value is presented:

$$|G| = \sqrt{Gx^2 + Gy^2} \tag{2.6}$$

Though typically, convergent dimension is calculated using:

$$|G| = |Gx| + |Gy| \tag{2.7}$$

Whose is the faster to enumerate.

The degree of direction of the border presenting elevation to the locative tendency (depend on the pixel of the grid orientation) is presented by:

$$\theta = \arctan\left(\frac{Gy}{Gx}\right) - \left(\frac{3\pi}{4}\right) \tag{2.8}$$

Employing this visor, the convergent volume is presented by

$$|G| = |P_1 - P_4| + |P_2 - P_3| \tag{2.9}$$

2.2.1.4.2 Prewitt edge detection

This edge detection was developed by Judith M. S. Prewitt. Appreciation to the volume of the border Prewitt is on the right direction. Likewise, extraordinary angle edge identification needs a completely time weariness computation to discover the heading from the qualities in the x and y-bearings, the range border admission discover the route particularly from the piece with the ultimate noteworthy answer.

2.2.1.4.3 Sobel edge detection

The Sobel system is utilized as a part of picture preparing, particularly inside edge identification program. It is a separated separation director, registering an estimate of the angle of the image values work. Thus, the ingredient of the inclination might be detect employing the attached parataxis:

$$\frac{\delta f(x,y)}{\delta x} = \Delta x = \frac{f(x+d_{x,y}) - f(x,y)}{d_x} \tag{2.10}$$

$$\frac{\partial f(x,y)}{\partial y} = \Delta x = \frac{f(x+dx,dy) - f(x,y)}{dy} \tag{2.11}$$

Which dx & dy Figure range straight the x & y instructions correspondingly. In separated picture, only one can look at dx & dy is numbers of pixel through2 facts. dx= dy = 1 (pixel spacing) is that point at that pixel assortment are (i, j),

$$\Delta x = f(i+1, j) - f(i, j) \tag{2.12}$$

$$\Delta y = f(i, j+1) - f(i, j) \tag{2.13}$$

With a view to find the turnout of a propensity intermission, one could Figure the variation in the slope at (i, j).This able to be completed by detecting the attached dimension:

$$M = \sqrt{(\Delta x)^2 + (\Delta y)^2} \tag{2.14}$$

And the orientation θ is presented by

$$\theta = \arctan \frac{\Delta y}{\Delta x} \tag{2.15}$$

Processing the pseudo-convolution factor as presented. Using this mask, the convergent dimension is presented by

$$|G| = |P_1 - P_4| + |P_2 - P_3| \tag{2.16}$$

2.2.1.4.4 Canny edge detection

According to (Canny, 1986), the fundamental objective of this Edge detection are the followings:

1. Elevated level of detection: Have a depressed endurance of unsuccessful to realize the true edge points, and have a depressed endurance of false doing the non-edge points. Since jointly these endurances are lessening functions of the produce signal-to-noise rate, this standard coincides to maximizing signal-to-noise rate. So essentially, it hastes sign as numerous true border as potential.

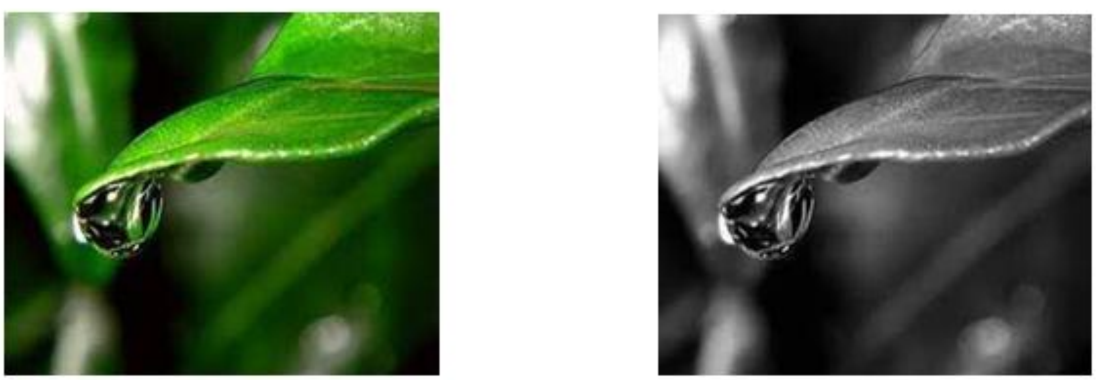
2. Abnormal state of confinement: The call attention out as borders concentrates by the manager should to be adjacent conceivable to focal point of the genuine border.

3. Least reaction: The one reaction to outright edges. It is certainly caught the principal rule since from there are two reactions to a similar border, one of them have to be investigated not genuine.

2.2.1.5 RGB to GRAY conversion

Humans perceive colors through wavelength-sensitive cells called cones. There are three deferent types of cones cells that can detect different electromagnetic radiations. One is sensitive to green light, one to blue light, and one to red light. The combination of these three colors can generate any other color which is also detectable by these three types of cells. the stored color image is called an RGB image. In grayscale images, the total amount of emitted light for each pixel can be differentiated and calculated where the pixels are divided between dark and bright pixels.

Processing RGB images is very complex compared to grayscale images although processing colored imaged can provide better results. There are two ways to convert RGB images to grayscale. First, average method is the simplest method where the average of the three colors (R+G+B/3) is taken. However, since the three colors have different wavelength, the resulting image will be very dark. Consequently, weighted method is better since the conversion depends on the wavelength of each color alone and thus the following equation $[(0.3 \times R) + (0.59 \times G) + (0.11 \times B)]$ is resulted. As a result, green contribute in 59%, red contribute in 30%, and blue contribute in 11%.



(a) Original RGB image before conversion (b) Resulting grayscale image

Figure 2.5: RGB to grayscale conversion (Nafchi, Shahkolaei, Hedjam, & Cheriet, 2017)

2.2.1.6 Image background subtraction

Digital image background subtraction has been used widely in computer vision applications and other image processing related fields. Background subtraction is the technique used to subtract data from two images in which the pixels values in the two images is subtract. Image subtraction is good for detecting differences in a series of images in order to detect and track an object such as cars, humans, etc. It compares the previous frame from the current frame by using different techniques such as basic motion detection, Gaussian mixture model and Kernel density estimation. Most background subtraction techniques label every pixel in the frame and delete those who have the same value from the background image. Mainly object motion detection begins with image thresholding in order to segment the object from the background. First a background image is captured and then taking frames at time t in order to subtract them. The simplest technique is to get the value of each pixel in the frame and subtract it from its corresponding pixel value in the background image. The equation of image subtraction is as follows:

$$P\big(I(t)\big) = P\big(F(t)\big) - P(B) \qquad (2.17)$$

Where;

I(t): result image at time t

F(t): frame image obtained at time t

B: background image

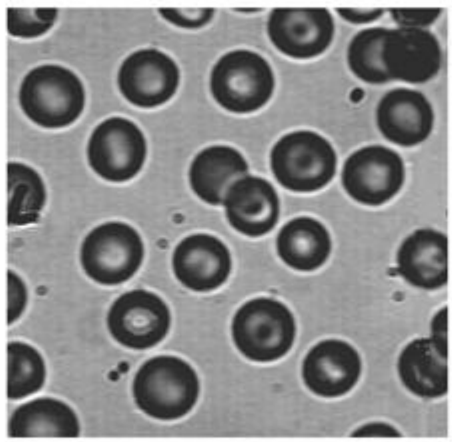
The results of this equation will present a picture where it will show the intensity where the pixel values have changed in the two consecutive frames.

(a) Original image (b) Result of background subtraction

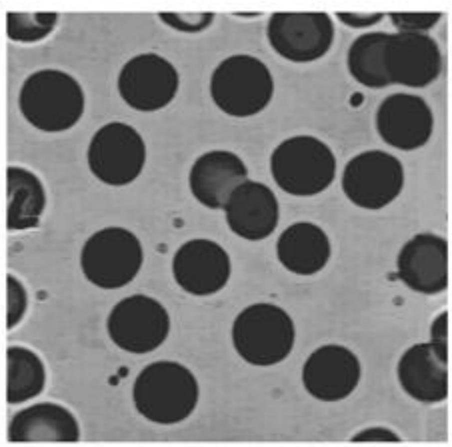
Figure 2.6: Image background subtraction

2.2.1.7 Image holes filling

A hole is background region that is subset of an object. During image processing of a frame, a frame maybe produced with some missing regions or pixels, so we use the hole fill method to close and fill this missing data. During segmentation of an image some holes are added to the image, using holes fill technique in order to eliminate these extra produced holes. The holes fill method do a flood-fill operation on a binary image. It changes the connected background pixels whose value is 0 to foreground pixels whose value is 1 till it reaches the object boundaries.



(a) Original image



(b) Image after filling holes

Figure 2.7: Image holes filling

2.2.1.8 Image matching

Image difference calculation is the most popular and simplest way to find differences between two images. If two images are identical, the difference calculation will produce a blank black image where each pixel has an intensity value of zero RGB (0, 0, 0). In case of differences, the regions with different intensity values between two images will light up. This is where the easy part ends and the hard part begins. Recognition techniques based on matching represent each class by a prototype pattern vector. The simplest approach is the minimum distance classifier, which computes the Euclidean distance between the unknown and each prototype vector. We have used a different approach for image matching. Comparing reference image with the real time image pixel by pixel. Although there are some disadvantages related to this technique but it is one of the best techniques for the algorithm which is used in the project for decision making. For images to be same their pixel values in matrix must be same. This is the simplest fact used in pixel matching. If there is any mismatch in pixel value it adds on to the counter used to calculate number of pixel mismatches.

2.2.2 Image preprocessing

In image preprocessing, image data registered by prospector on disciple confines errors recognized with geometry and brilliance appreciations of the pixels. Those mistakes are remedied employed proper scientific samples, whose are each clear or the volumes samples. Image improve is the adjustment of image in variable the pixel luminosity goodness to promote its visible impact. Image improve contains a collection of strategies that are applied to promote the visible occurrence of an image, or to modification through the image to a framework, which is more capable for epidermal or engine elucidation (Kumar, Chandrakant, Kumar, & Kushal, 2014; Pornpanomchai & Kongkittisan, 2009).

2.2.3 Image classification

The recreation comes about verified that the planned controlling achieves improved with the combined broadcast vivacity metric from the most extreme quantity of recoils metric. The projected intention springs vivacity productive mode to evidence broadcast and augments the generation of total organization. By way of the performance of the projected control is broke down among two capacities in upcoming through a rare adjustment in plan examinations the implementation of the projected intention can be compared and additional vivacity productive control. We take applied petite organization of 5 centers, as number of centers expands the intricacy will increase. We can build the number of centers and break down the implementation (Adnan, Sulaiman, Zainuddin, & Tuan Besar, 2013; Goda et al., 2014).

2.2.4 Image enhancement

One imperative subject in picture preparing is picture improvement. Picture improvement includes a gathering of systems which are utilized to enhance the graphic entrance of a picture, or to change over the picture to a shape, that is more qualified for humanoid or engine elucidation. Isn't broad hypothesis of picture upgrade because being broad standard for the nature of a picture in this manner, diverse classes of strategies were created over the previous decades.

2.3 Video Processing

In run of the mill video successions, the scene content remains primarily the same from casing to outline. This infers that for undertakings like clamor decrease and missing information addition. There is substantially more information that can be helpfully utilized to uncover the hidden 'unique, clean' information than with still pictures. For example, consider a succession demonstrating a news analyst perusing the news, and say that one of the outlines disappears. Since we realize that the scene did not change much between outlines, we can basically supplant the missing edges with one of the known ones adjacent in time. We couldn't do this in the event that we had a photo and 90instance. Figure 2.8 demonstrates a straightforward case showing the two essential ways to deal with handling video information. Handling might be accomplished without recognizing movement or utilizing movement remuneration.

In the non-movement remunerated preparing, information is separated from the video stream along a direction that is dependably at right edges to the plane of the picture. Pixels relating to the same area in space are just gathered and handled as though they originated from the same hidden factual process. This is appeared in the best piece of the outline.

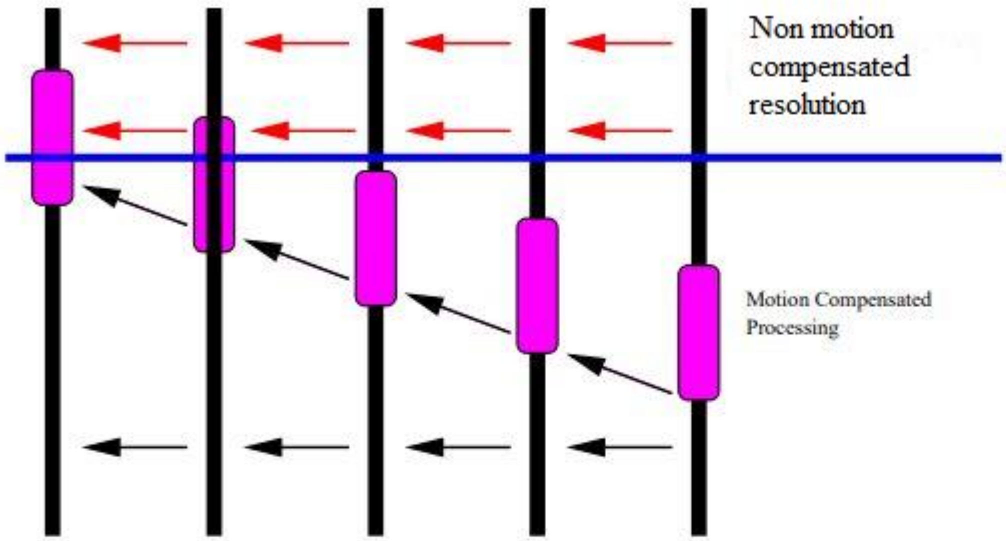


Figure 2.8: Motion compensated and Non-motion compensated video processing

Utilizing movement remunerated preparing, pixels are extricated along movement directions. These directions must be evaluated utilizing one of the movement estimators as examined already in this course. This kind of preparing is appeared in the base portion of Figure 2.8.

The Figure demonstrates development of a solitary protest against a foundation. Movement is regular of intriguing video. The hidden thought of all video handling calculations is to abuse the fleeting repetition between outlines. However the movement causes complexities. In the best 50% of Figure 2.8, the pixels removed do for sure have a relationship to each other at first, yet as we go additionally back in time, in the long run the separated information crosses the way of a moving item which at that point devastates the factual homogeneity. This is on the grounds that the moving article is ordinarily irrelevant to the foundation (else we would likely not have the capacity to see it).

CHAPTER 3
THEROTICAL FRAMEWORK

3.1 Mathematical Representaion of Filter

The filter configuration incorporates the multiplicative minimum square strategy to remove the parameter coefficients. The multiplicative slightest square technique was as of late presented in (Cornel S. Pintea, 2012). According to the general definitions as in mathematics, the multiplicative based slightest square technique takes the common formula as:

$$S = \exp\left\{\sum_{i=1}^{n} \ln\left(\frac{y_i}{f(b, x_i)}\right)^2\right\} = \prod_{i=1}^{n} \exp\left(\frac{y_i}{b, x_i}\right)^2 \qquad (3.1)$$

Where; y_i refers to the momentary yield at comparing input pixel estimations of x_i. The upside of this strategy is that numerous exponential capacities are straightly handled and they deliver exactness with less computational time. See Figure 3.1

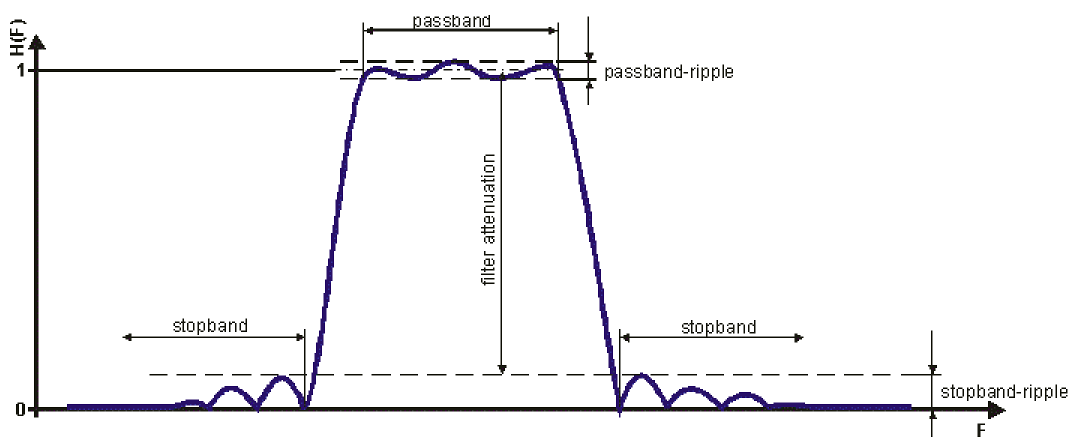


Figure 3.1: Ideal band-pass filter

The condition (2) is generally reliant on the restriction factors of vector b. Thus, condition (2) is connected to a minimization technique. These parameters are all within the array b and can be described as bi. Subsequently, one ought to limit S as for parameter i.

$$\left(\frac{\partial s}{\partial b_i}\right)^* = \exp\left\{\frac{\partial}{\partial b_i}\sum \ln\left(s_i\right)\right\} \tag{3.2}$$

In multiplicative calculus the above mentioned equation needs to be set to 1 to obtain a minimization process. Hence, the given equation is written as:

$$\left(\frac{\partial s}{\partial bi}\right)^* = \exp\left\{-\sum_{i=1}^{n} 2\ln\left(\frac{y_i}{b, x_i}\right)\frac{1}{f\ (b, x_i}\ \frac{\partial f\ (b, x_i)}{\partial b_i}\right\} = 1 \tag{3.3}$$

This infers condition (5) create number of new conditions in light of the parameters connoted by subscript I. The goal of the new model is to acquire the parameter esteems with the end goal that it will create the nearest match of the tainted district of the leaf. This paper actualizes the multiplicative adaptation of minimum square technique to fit the recorded information with recently presented exponential model. The proposed channel work is characterized as:

$$f\ (c, x) = x^{c_1} e^{\left(c_2 x^2 + c_3 x + c_4\right)} \tag{3.4}$$

The parameter values c_1, c_2, c_3 *and* c_4 in the filter function allow large degree of flexibility. It covers Gaussian, increasing/decreasing exponential, linearly varying data. The parameters values c_1, c_2, c_3 *and* c_4 have great impact to smooth out the area of interest on the image. Classical calculus faces difficulty to process and reveal the parameter values therefore we used the geometric calculus. The parameter values can be identified by the solutions of the following mathematical equations.

$$\left(\frac{\partial s}{\partial c_1}\right)^* = \exp\left\{-\sum_{i=1}^{n}\left(\ln(c_i)(\ln(y_i) - c_1 \ln(x_i) c_2 x_i^{\ 2} - c_3 x_i - c_4)\right)\right\} \tag{3.5}$$

The parameter values c_1, c_2, c_3, c_4 obtained from the solution of the equations (3.5). The parametric values are substituted into equation (3.5). The function in equation (3.4) processed the same as the Gaussian, low pass, and high-pass filter function and produces more effective results.

The new sort of band-pass channel work orchestrated and related in three phases for includes extraction. Each band-pass channel utilizes the current condition with the pixel respects to pick the new coefficient respects. The parameter respects are self-ousted from the pixel respects. This connects with by and large correct fit to the application. This kind of channel can perceive the pointed pixels with high exactness. The three stage band-pass channels have unmistakable extent of breaking point regards for ID.

3.2 Gaussian Filters

The general Gaussian distribution in one dimensional array can be given under the form:

$$G(x) = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{x^2}{2\sigma^2}} \tag{3.6}$$

Where; σ represents the standard deviation. The average or statically mean has been assumed to be zero in the distribution. Figure 3.2 illustrates the general curve of the Gaussian distribution.

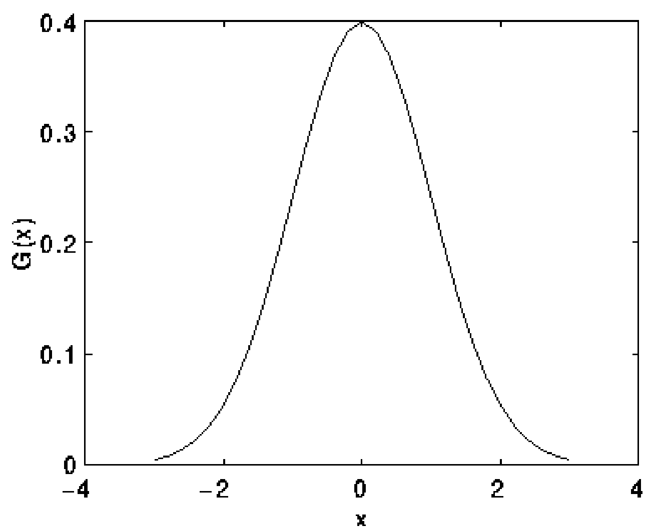


Figure 3.2: Gaussian distribution with zero mean and unit standard deviation

In two dimensional distributions, an isotropic Gaussian distribution such as circularly symmetric is given by:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \tag{3.7}$$

The curve of two dimensional Gaussian distribution is illustrated in Figure 3.3.

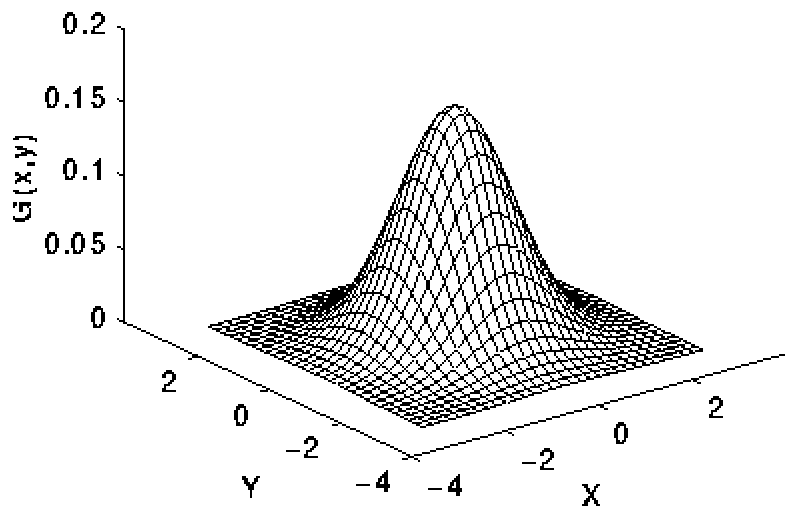


Figure 3.3: 2-D Gaussian distribution with mean (0, 0) and σ=1

Gaussian smoothing is possible by using a two dimensional development as cut off point spread. The two dimensional development is accomplished by using mathematic convolution process. Since images are stored in form of discrete pixels, discrete estimation of these pixels is indispensable to be able to carry out the convolution process. In general, the Gaussian distribution is considered as a non null distribution around the mean. This distribution requires a free convolution process. After convolution, the distribution will have standard deviation of 3 from the mean. Around the standard deviation lines, the required parts can be truncated. In Figure 3.3 a Gaussian distribution is demonstrated with a reasonable number respected convolution piece of 1.0. However, the selected estimates of the cover are unclear in their methods, one of these methods can merging a pixel in the cover by utilizing the Gaussian estimation. Since the complexities in Gaussian estimation completed the pixel in a manner that is not strict, for this reason the previous method cannot be considered true, and therefore, the Gaussian estimation over the entire pixel must be combined by finding the combination of Gaussian at 0.001 .However, the integration process are not applied to all numbers so the show is rescaled by the target that the corners have the respect 1. Then finally, the number 273 is the aggregate number of the noteworthy of qualities. Once a sensible part has been Figured, then through the utilize of the standard convolution procedures the Gaussian smoothing is performed. Actually, this process is implemented modestly quick where the condition of the two dimensional isotropic Gaussian showed up is unmistakable in the parts of x and y. Along these lines of the two dimensional convolution could be carried out with a one dimensional Gaussian in the x bearing through the first convolving, followed by a convolving with one more one dimensional Gaussian in y course, where the Gaussian is the principle absolutely circular symmetry director that could be decayed .In Figure 3.4 illustrates x section piece of one dimensional which could be utilized to convey the complete part.

In the wake of scaling by 273, altering and truncating one segment of pixels around the breaking point since they by and large have the regard 0. This reduces the 7x7 structure to the 5x5 showed up already.). The y section is accurately the same however is arranged vertically.

.006	.061	.242	.383	.242	.061	.006

Figure 3.4: An example of one pairs which is used to compute rapidly the full kernel in one dimensional convolution kernels

In case of a huge standard deviation of a Gaussian smoothing , it is possible to convolve a photo with mean Gaussian a couple of times as a future technique, by using a gear channel the planning is finished harmoniously since this operation is change mathematically.

In the field of planning application, it is not simple for Gaussian filter to have efficacy. It is moreover pulling in thought from computational researchers since it has been credited with some measure of normal acceptability. For example, a Gaussian response is a normal response of a couple of cells in the pathways image of the psyche.

The Gaussian smoothing is impact by obscuring a picture in a comparable form to mean channel. However, the standard deviation is used to control the level of smoothing. Obviously, the bigger standard deviation need bigger convolution bits keeping in mind the end goal to be precisely spoken to.

The Gaussian yields a `weighted normal' of every pixel's neighborhood is weighted normal towards the estimation of the focal pixels with the normal weighted as the Gaussian yields. This yield of Gaussian is as opposed to the mean channel's consistently weighted normal. Along these lines, a Gaussian gives gentler smoothing and jam edges superior to anything a correspondingly estimated mean channel (Barriga-Rivera & Suaning, 2011).

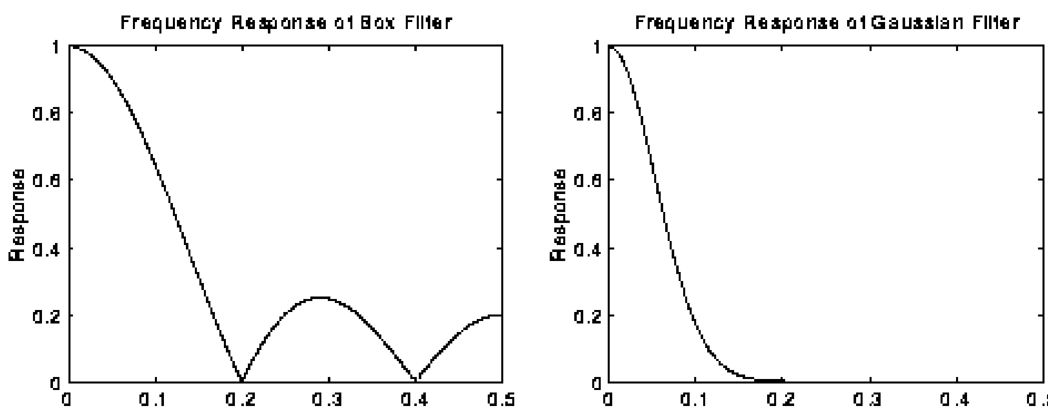


Figure 3.5: A graph of the frequency responses curves for box and Gaussian filters with different channel width.

The Gaussian filter is utilized as a smoothing channel which is one of the standard supports in utilizing the Gaussian because of its recurrence reaction. The majority convolution which is based on the smoothing channels goes about as low pass recurrence channels which is implies the impact in expelling the parts in a picture with a high spatial recurrence. In order to clarify the recurrence reaction impact of a convolution channel on various spatial frequencies, the Fourier change for the channel is taken. The recurrence reactions for one dimensional mean channel is illustrated in the Figure 3.5 ,where the width of a channel in box filter is 5 pixels ,while the width is 3 pixels in the frequency response of a Gaussian filter.

3.3 Linear Filters in the Spatial Domain

The moving typical, or box channel, which conveyed Figure 3.6 (b) is the slightest troublesome of all channels. It replaces each pixel by the typical of pixel regards in a square engaged at that pixel. Each immediate channel work also except for that, as opposed to forming a clear ordinary, a weighted typical is confined. Using the wording of section 1, let f_{ij} , for I, j = 1,...,n, mean the pixel regards in the photo. We will use g, with pixel regards g_{ij} , to connote the yield from the channel. An immediate channel of size $(2m+1)\times(2m+1)$, with decided weights w_{kl} for $k,l = -m, \ldots, m$, For full clearing proclamation, the weights (w) can depend upon I and j, achieving a channel which moves over the photo. In any case, the immediate diverts considered in this area will all be spatially invariant. In like manner, each one of the channels will have windows made out of odd amounts of lines and areas. It is possible to have even-sized windows, yet then there is a half-pixel evacuation between the data and yield pictures.

Diverse potential results exist for overseeing them:

1. They could be discarded, achieving g being more diminutive than f.

2. The pixels in the edges of g could be consigned an undefined regards from those in the edges of f.

3. The edge pixels in g could be set to zero.

4. The channel could be modified to manage inadequate neighborhoods, for example:

(a) by expelling those parts of the district which lie outside the photograph,

(b) by reflecting the data picture (f) along its first and last line and section, with the objective that pixel regards $f_{i,n+1} = f_{i,n-1}$ et cetera,

(c) by wrapping-round the information picture so $f_{i,n+1} = f_{i,1}$ et cetera, similarly in a manner of speaking on a torus.

In this part we will take decision 2 for smoothing stations and decision 3 for edge-revelation channels, where we will settle on use of decision. Totally, this wrap-round approach is the principle honest to goodness elective for the numerical results on straight channels to be significant over the whole picture. If each one of the parts in positive, by then the effect of the channel is to smooth the photo. The two most customarily used channels of this compose the moving typical and the Gaussian will be considered. If a couple of weights are negative, by then the channel yields a differentiation between pixel regards, which can have the effect of focusing on edges.

3.4 Linear Filters in the Frequency Domain

Instead of addressing a photo as an n×n group of pixel regards, we can then again address it as the aggregate of various sine surges of different frequencies, amplitudes and course. This is implied as the repeat zone or Fourier depiction. The parameters deciding the sine waves are named Fourier coefficients. For a couple of specialists, particularly constructs, this show up an obvious action for others, it may take some getting used to. The reasons why we are receiving this system are:

Additional understanding can be picked up into how straight channels function by considering them in the recurrence space.

Some straight channels can be Figured all the more proficiently in the recurrence area, by utilizing the Quick Fourier Change (FFT) (Maini & Aggarwal, 2009).

New channels can be recognized.

We will exhibit the fundamental hypothesis of Fourier changes. At that point, in we will take a gander at the straight channels. At last, we will build up some new channels by indicating them in the recurrence area. The less-numerical peruse May like to avoid whatever remains of this area, which should be possible without losing the feeling of whatever remains of the section.

3.5 Template Matching:

Rather than speaking to a picture as an n×n cluster of pixel esteems, we can on the other hand speak to it as the total of numerous sine rushes of various frequencies, amplitudes and bearings. This is alluded to as the recurrence area or Fourier portrayal. The parameters determining the sine waves are named Fourier coefficients. For a few researchers, especially builds, this appears an undeniable activity for others; it might take some getting used to. The reasons why we are adopting this strategy are:

Additional understanding can be picked up into how straight channels function by considering them in the recurrence space.

Some straight channels can be Figured all the more proficiently in the recurrence area, by utilizing the Quick Fourier Change (FFT).

New channels can be recognized.

We will exhibit the fundamental hypothesis of Fourier changes. At that point, in we will take a gander at the straight channels. At last, we will build up some new channels by indicating them in the recurrence area. The less-numerical peruse may like to avoid whatever remains of this area, which should be possible without losing the feeling of whatever remains of the section.

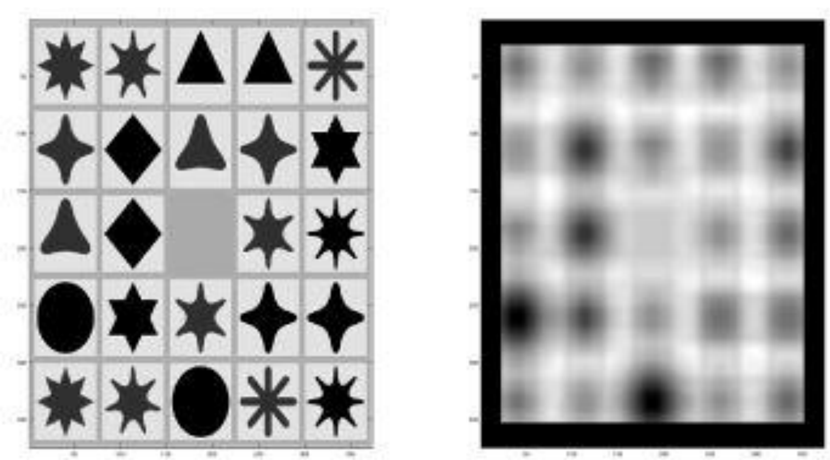


Figure 3.6: (a) the Figure of original shapes (b) the Correlation of image with W45

In order to enhance the matching outlook, the correlation image of the previous one will be inverted, this process will whiten the areas with the maximum correlation, secondly, the threshold view of the map which is illustrates the correlation could be considered (Gonzalez & Woods, 2001).

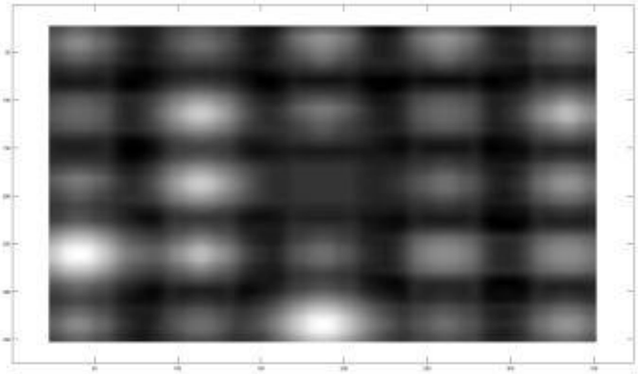


Figure 3.7: Image of correlation after applying the inverting

As we can see on the previous image, there seems to be 2 spots where the correlation is big and maybe other few areas. The two big white areas are indeed the circles, but let's are sure of it by firstly looking at the height surface associated to this image.

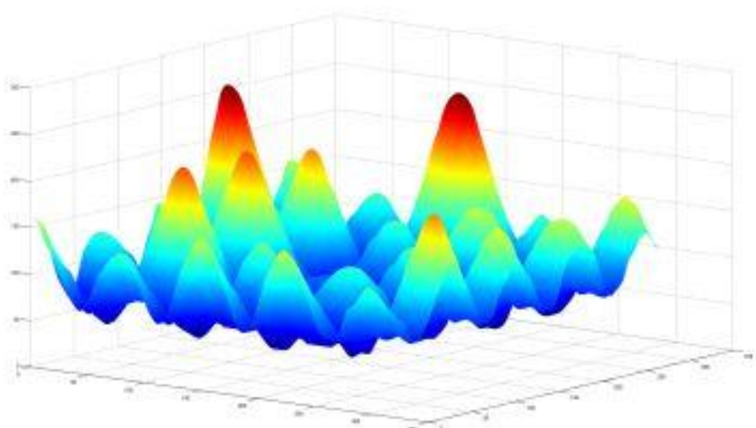


Figure 3.8: An illustrative map of the correlation height

Or it could be secondly consider the threshold version of our correlation map.

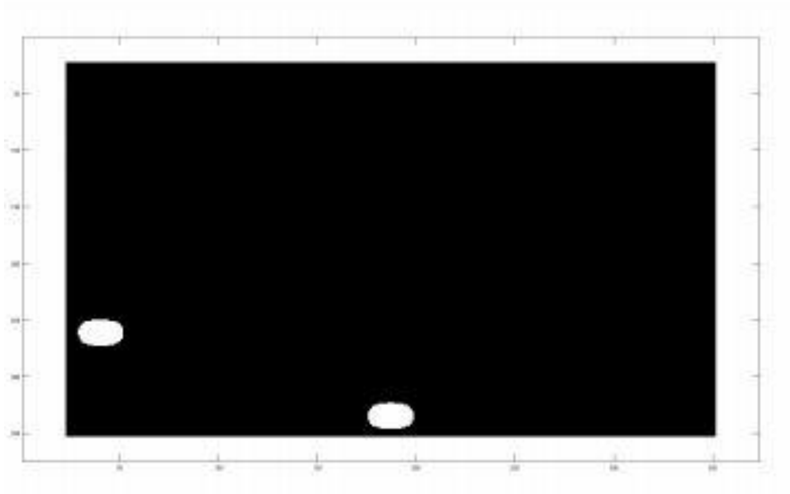


Figure 3.9: An illustrative map of the correlation in binary representation

Additionally, as we expected in general rule, the two white points which were previously arranged are the maximum of the relationship. It is obvious that a Figure of the circle works extremely well. Nevertheless, two important points must be taken into account and will be discussed. Immediately the examination will probably be wrong in the case of taken picture was more prominent, in other words the tinier square that will be appropriate more noteworthy number of formalize than simply the circles. Another reworked relationship outline exhibits the result with a 25 × 25 square. Moreover, as ought to be clear there additional zones where the relationship is high because the square is appropriate.

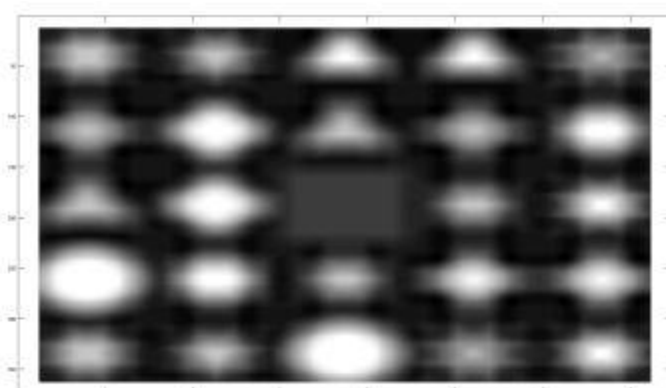


Figure 3.10: Image of correlation with W25 after applying the inverting

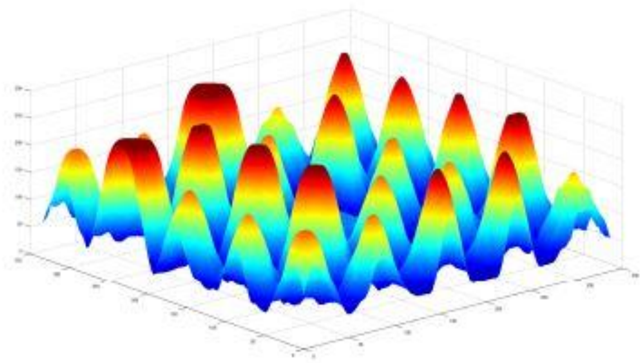


Figure 3.11: An illustrative map of the correlation height

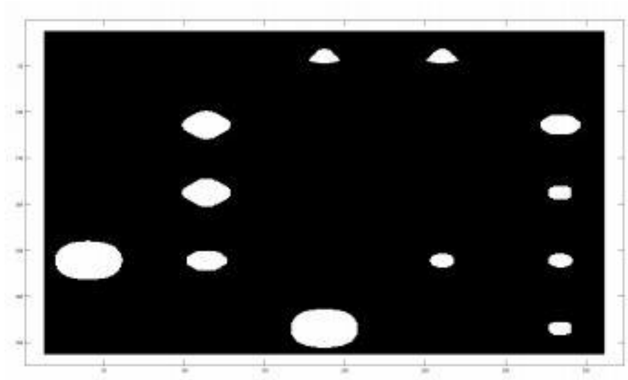


Figure 3.12: An illustrative map of the correlation in binary representation

Something unique is to a great degree fundamental here is our technique to oversee borders. Certainly the more prominent the part the humbler the photo will be. Also, in the correct case, a gigantic structures will be searched, which we can't for the most part assessed so an accommodating course of action in this photo is incorporate an edge around with half size of the piece and with the establishment regard. For this circumstance, where our case as a to a great degree specific diminish regard it won't interfere or change the photo.

The photo of the shape outlines is from far the slightest requesting to look at and to work with in light of the fact that we have gigantic shapes, in addition the cases are extremely simple to find and all around detached from each other, however it can be said that the principle ungainly is the immense size will need a more expanded count time, and this mean the need to endeavor with the substance picture and the character "a" as well.

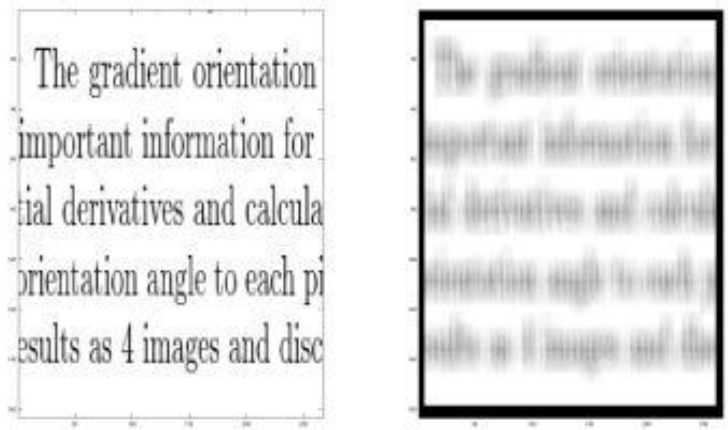


Figure 3.13: An illustrative pictures of the text and correlation map

Figure 3.14: An illustrative map of the correlation

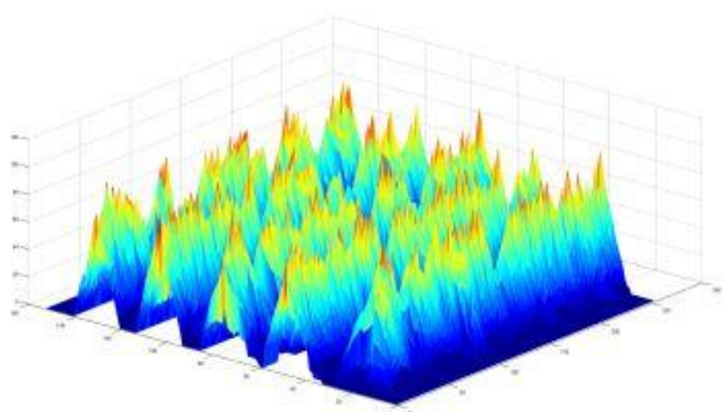


Figure 3.15: An illustrative map of the text correlation height

As is evident from the past findings, it is more difficult to obtain the circumstance of "an" accurately within a substance picture, since the items are smaller, more convergent and can't be distinct simply. In this case a charming strategy will involve taking a virtual plan which is the climb long the z turn of the plane to perceive thresholding. In order to acquire the region that we are hunting down, an adequate farthest point must be found as a main purpose. When we found a better than average point of confinement we can look at the territory found and check whether they arrange with what we are hunting down. Here is the twofold picture happening on account of a most extreme thresholding and the accomplice stature layout:

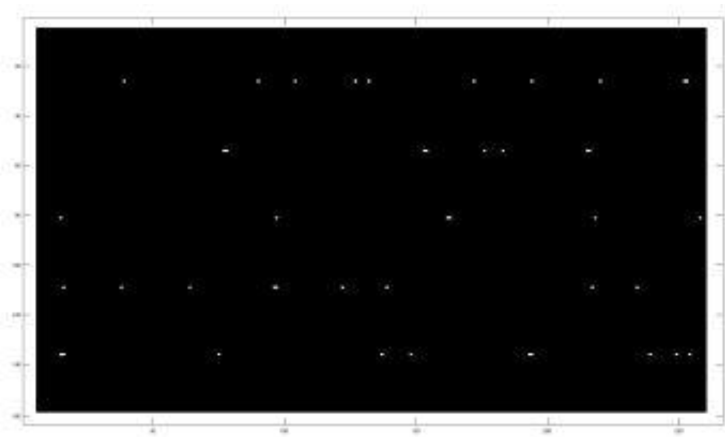


Figure 3.16: An illustrative map of the text correlation after applying threshold

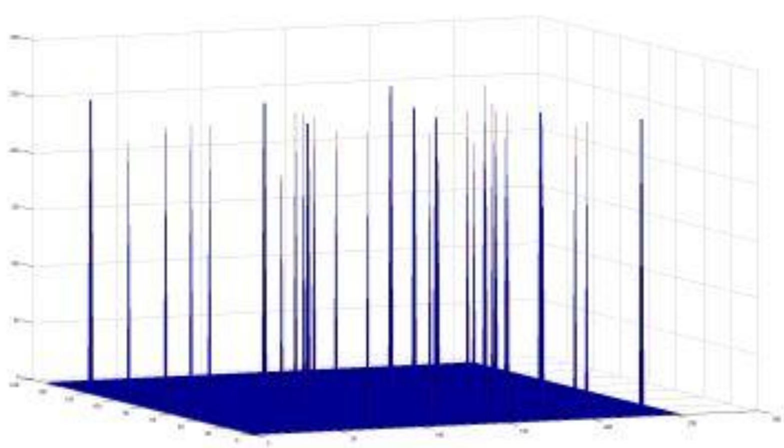


Figure 3.17: An illustrative map of the text correlation height after applying threshold

The previous height map is like a Dirac forest where all the Dirac is representing a pixel where correlation with our template is high. If we analyses it we have 35 peaks while in reality we have 15 a in the image. So let see which of the peaks are actually representing a real and what to the other represent.

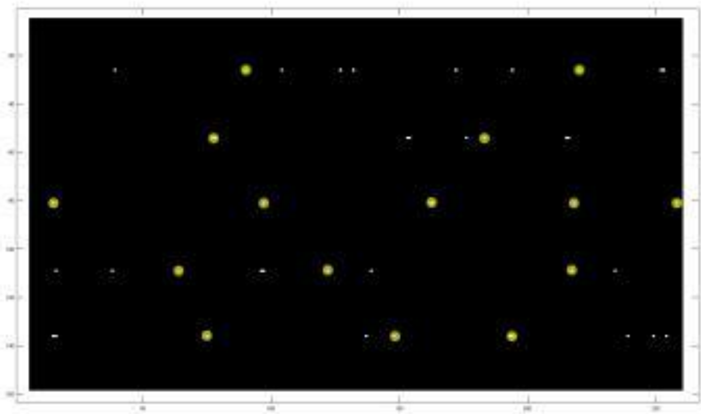


Figure 3.18: Highlight of pattern in text correlation map after threshold

So as indicated by the past outcome, we can see that all our 0 are recognized, yet additionally different letters. This is the place it gets precarious on the grounds that the limit must be sufficiently high to evacuate however many 33 different letters as could be expected under the circumstances, yet not very high to keep the 0. In the past Figure, on the off chance that we augment the limit estimation of a solitary unit, we lose a few a 0 s which isn't what we need, in light of the fact that their relationship esteem is lower than the connection with different letters which could appear to be wrong however which really makes sense on the off chance that we consider that letters an extremely close and that every one of the a 0 s of this picture could be somewhat not quite the same as each other. For sure, it appears that the characters in the content are not homogeneous so each of the 0 could be extraordinary. So the arrangement could be to edge the picture previously. So we attempted that viewpoint and we discovered that it was not more powerful. Here is the outcome:

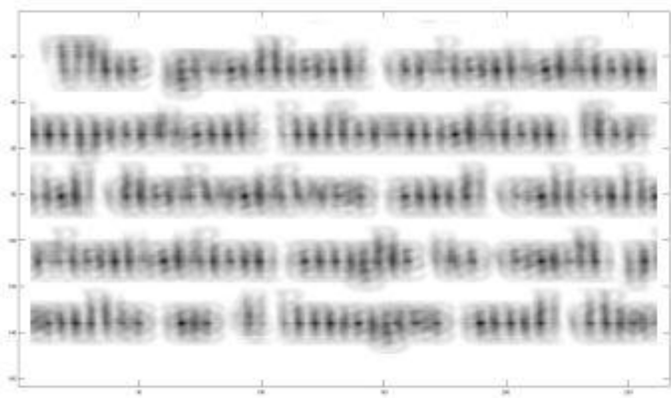


Figure 3.19: An illustrative map of the correlation of text in binary representation

In that case, it is really difficult to have what we need, so in light of the outcome with only couple of specks we can discover the area of our a 0 s yet in addition some different letters. When we have that we could store the area of the rest of the spots into a vector to register the connection just for those correct areas. We executed this and we discovered that the connection of every one of these focuses was extremely close and we didn't Figure out how to isolate the 0 from alternate letters.

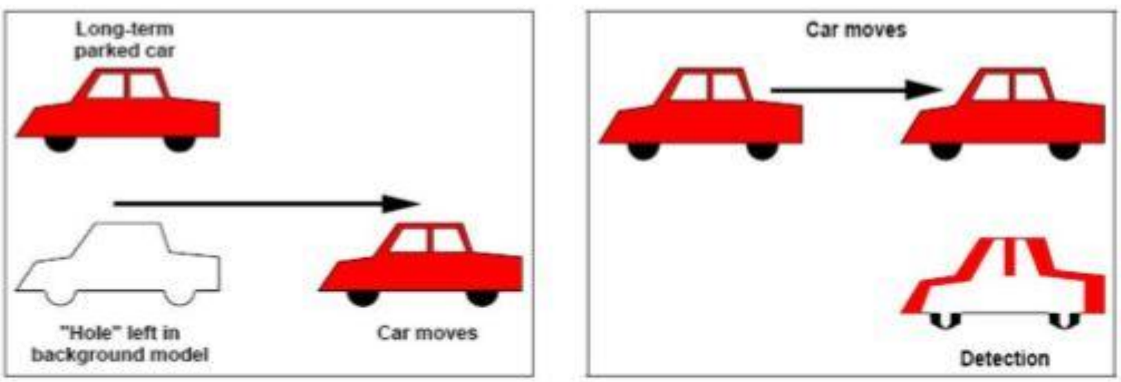
CHAPTER 4
SYSTEM DESIGN

4.1 Proposed Methodology

This zone quickly talks about SDCS novel method, framework point by point structure and undertaking execution. SDCS can be confined into four dynamic stages; these are Things disclosure, Things following, Speed estimation and Getting Article's Photograph Area for the articles that move within the streams of video is recognized as a massive, and troublesome, study issue. Close by the inborn advantage to has the ability to split the video into parts that move within the video stream and foundation parts, in addition to perceiving the points that move and gives a union status of quickness regarding confirmation, social event, and action examination, this is what makes that later technique further effective in view of the fact that essentially "moving" pixels require to be taken into account. The reason for disagree following is to build up a correspondence among things or question parts in endless edges. It additionally expects to segregating transitory data about articles, for example, bearing, position, speed and heading. Following perceived things design by chart, in video is a basic and troublesome undertaking. It is a critical piece of shrewd recognition structures. This is in light of the way that without question following, the framework couldn't expel strong transient data about things. In such cases, greater total lead examination steps would not be conceivable. Obviously, misinformed closer observe question division in perspective of shadows, reflectance and deterrents impacts following a troublesome research to issue. Since the yield of question territory compose is broadly attempted and genuine and it addresses the unexpected variations in the light and shadows. In this manner theses bleeding edge pictures are set up for division, stamping and following. Also, the articles' rates can be Figured by recognizing the fundamental bundling that the test has came into the sight at (Fr0) then watching the request until it goes out the sight at plot (Frn) at the same time as disregarding all other unessential disputes, for example, individuals crossing the street.

4.1.1 Object detection

A Half breed calculation for identifying moving items is utilized. It depends on consolidating a versatile foundation subtraction procedure with a three-outline differencing calculation. This blend endorses the real downside of utilizing just versatile foundation subtraction. That is it considers stationary protests in the scene that begin to move. Despite the fact that these are generally distinguished, they abandon "openings" where the recently uncovered foundation symbolism varies from the referred to foundation demonstrate as appeared in Figure 4.1.a While the foundation show in the long run adjusts to these "gaps", they produce false cautions for a brief timeframe. Casing differencing isn't liable to this wonder; nonetheless, it is for the most part not a successful strategy for separating the whole state of a moving article as appeared in Figure 4.1.b.



(a) Background subtraction the holes when the fixed car moves.

(b) Frame distinction doesn't recognize whole objective

Figure 4.1: Background subtraction and frame distinction

In order to address these issues, two integrated techniques will be utilized. Question recognition procedure that include three diverse progressive advances.

4.1.1.1 Constructing motion matrix

The essential concept in that zone involves building up a network looks at to the present packaging. This idea is set up to pick any pixels are in the process of being developed and any pixels are stable. However, the likelihood in address a frontal territory pixel in pixels that move could be considered high and the likelihood to address an establishment pixel in fixed pixels could be considered high. A three-layout distinction action has being carried out to choose districts of genuine development and that process could be called the building up of development organize, and this is illustrated in Figure 4.2. In order to remove all moved district, this process will trail by flexible establishment subtraction. The video stream is taken from offset camera or camera in stable state. Allow In(x,y) to address the power an impetus for pixel point (x,y), where time t=n. The three-layout distinction chooses prescribes that if the energy of the pixel has varied basically between the present picture (In) and the previous packaging (In-1) then a pixel is considered to be truly moving , the moved pixel (x,y) and a present picture (In) and the by previous edge (In-2).

$$\left(\left|\ln(x,y) - \ln -1(x,y)\right| > T\ (x,y)\right) \tag{4.1}$$

Where Tn(x,y) is a point of confinement depicting a quantifiably vital power vary at pixel location (x,y) (portrayed underneath) and T refers to the value of threshold. In layer distinction there is guideline issue with a couple edges differencing pixels inside a dissent and have a uniform power are rejected for the "moving" pixels in the game plan. Similarly, the three packaging distinction has high noise sensitivity. Regardless, in the case of utilize a small rate of edge the differentiation between three dynamic edges increasing will occur while in case for a high distinction rate the distinction of three edge will go about as couple edge distinction and including fairly more purposes of intrigue.

(a) Example of a couple moving items (b) the created motion matrix

Figure 4.2: An example of a motion matrix

4.1.1.2 The background subtraction

Give Bn(x,y) a chance to be the comparing foundation power an incentive of pixel location (x,y) evaluated after some time of video pictures I0 during In-1.

Following equation represents the closer view picture F(x,y)as :

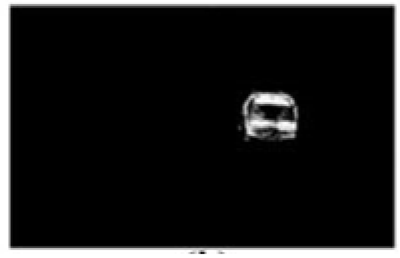
$$F(x,y) = 1 \text{ if } (|\ln(x,y) - B(x,y)| > T(x,y) \tag{4.2}$$
$$0 \text{ otherwise}$$

Where T refers to the threshold.

This condition is utilized by an extensive segment in the establishment subtraction methodology. However, the new condition relies upon this formula and development organize which we analyzed as of (now and again insinuated as the cover). Through the subtract process of the present packaging In (x, y) the establishment Bn(x, y) this development grid could be utilized as a cover.

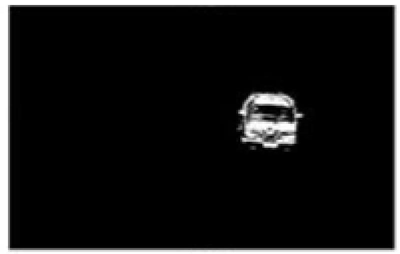
According to the main concept some pixels don’t need the implementation of subtraction operation that’s because of its absence within the movement area, in other words these pixels aren’t in development thusly. Toward the day's end, if the pixel isn't moving so we will slight these pixels where the likelihood of the fixed pixel for being a bit of a dissent is considered as small probability , in other hand the likelihood of development pixel for being be a bit of question is very high. Dismissing distinctive pixels could lead to make the information lost, in addition to incite un-related items. Regardless, we join the yield that the action of the outcome for a couple packaging transient distinction where the transitory distinction recognize around 35-half of the inquiry. That has been shown to provide an extraordinarily astonishing outcome as showed up in Figure 4.2. Wherefore, through the utilize of the hide subtraction procedure for the frontal zone picture F(x, y) could be created, and a couple packaging distinction methodology.

(a) Sample of moving object



(b) Foreground image

(c) Foreground image with two frame



(d) Final foreground image after merging both images

Figure 4.3: Masked subtraction example

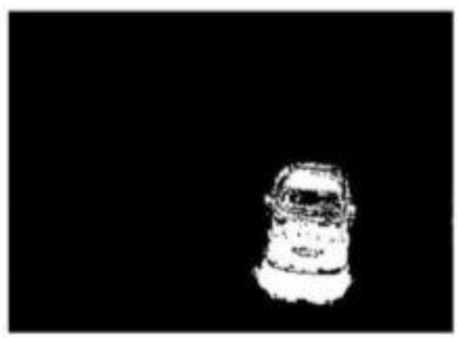
A large portion of the forefront identification calculations are defenseless to the two shadows and sudden light changes which cause incorrect frontal area protest division. Since later handling advances like protest grouping and following rely upon the rightness of question division, it is essential to adapt to shadow and sudden brightening changes in shrewd reconnaissance frameworks.

Consequent to dissecting the characteristics for the shade presumes that the shade locale is gloomier in addition to that areas address a comparable establishment surface under a lessened lighting up, and offer relative surfaces to the establishment. There are two philosophies of shade disclosure and elimination, first one based on utilizing edge area, while the other take a gander at the powers of pixel In(x,y), Bn(x,y).

In the essential method the burden is unconventionality, this one is a dreary method yet offer an exact outcome, moreover, this method could be utilized to isolate the self-shade from cast shade, however, this application guideline method is rapid during the recalling quality, and the other method has been utilized. Frugally we require a vivacious with adaptable methodology for distinguishing the present of pixel In(x,y) if it is a frontal region or shade. Later than endeavor and check, we contemplated that the pixels are considered in shade when the ration In(x,y) / Bn(x,y) is larger than 0.23 and smaller than 0.95.

In this system it is clear and flexible for broad assortment of shades and the breaking points must be kept at these couple regions and that all together not to mess-perceive a shade point just in case of nearer see one. Disregarding the way that could impact the challenge for a number of excellent situations, such as the dawn time span, in any case it doesn't mess-arrange shadow. It will essentially perceive a tinier bit of the inquiry yet with no shadow by any methods. Along these lines we have assembled a nearer see picture with no shade. However when the adaptable establishment is utilized then it is flexible to unexpected edification variation. Other than this case, dynamic farthest point will be used and that ought to conform the situation of lighting.

(a) Sample of moving object



(b) Foreground image

(c) The foreground image constructed by masked subtraction after shadow removal.

Figure 4.4: Shadow removal sample

4.1.1.3 Generating new foundation threshold matrix

Both the foundation show Bn(x,y) and the distinction limit Tn(x,y) are factual characters for the power of pixel that saw in grouping of pictures {Ik(x,y)} for k<n.

B0(x,y) is in the first list of the principal picture, B0(x,y)= T0(x,y), while T0(x,y)) is in the first list of a pre-decided esteem with a value of 15.

The following mathematical equations are used to adjust and modify B(x,y) and T(x,y) with the time:

$$
\begin{aligned}
B_{n+1} &= \alpha B(x,y) + (1-\alpha)\,\mathrm{ln}(x,y) \quad moving \\
&= B_n(x,y) \qquad\qquad\qquad\qquad fixed
\end{aligned}
\tag{4.3}
$$

(a) Background

(b) New frame

(c) New background

Figure 4.5: New background generation

4.1.2 Objects tracking

Following distinguished things diagram by layout in video is a basic and troublesome endeavor. It is a critical bit of insightful perception systems since without dissent following, the structure couldn't remove firm transient information about articles and more raised sum direct examination steps would not be possible. On the other hand, off course frontal zone question division in light of shadows, reflectance and hindrances influences following a troublesome research to issue. Dissent following driven using three dynamic stages question division, protest marking and protest focus extraction.

4.1.2.1 Object segmentation

Question division is constructing basically upon the network of the items. As it were, with a specific end goal to fragment a frontal area picture into a gathering of items we should guarantee that each question is being associated as one section. Something else, division won't act in a proper way; this will bring about abundance objects tally since the single question is being dealt with the same number of a few items. Since the articles are not associated, we have to identify the zone which encompasses the items. Afterward, this zone can be dealt with as a superb delegate to the items that are un-associated; in other word, the task expects to outline protest into a rectangle speaking to it. This strategy comprises the progressive emphases; every emphasis comprises of two fundamental parts, level checking and vertical filtering.

The level checking begins from the best pixel in nearer see picture F (0, 0) which allocated in left .After that, system analyzes the frontal zone picture equitably. In the case that there is no white pixel in front line pixel, the entire yield stripe will be stamped. Otherwise, the scanning process in system will skirt the stripe in case of the white shaded pixel which has saw as bleeding edge and then go the accompanying yield stripe, Figure 4.5. (a) illustrates obviously the outcome after equitably separating the frontal territory picture. Moreover, for a vertically checking the system begins in like manner from the best pixel in frontal see picture F (0, 0) which allocated in left. In any case, in vertical process the system inspects the nearer see picture. In the case that the white pixel can’t be found, the system will check the entire yield stripe. Otherwise, in the case of presence the white tented pixel the scanning operation by system will skirt this stripe and go in accompanying yield stripe.

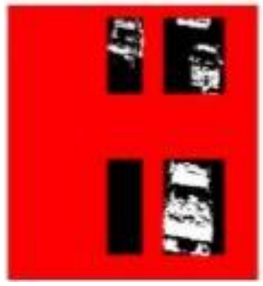


Figure 4.6: the first cycle in item segmentation

After primary cycle plainly despite everything we require another emphasis keeping in mind the end goal to give a precise outcome, alongside there exist false identified districts which will vanish after an extra emphasis as appeared underneath at Figure 4.7.

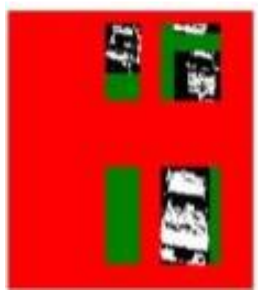


Figure 4.7: the second cycle in item segmentation

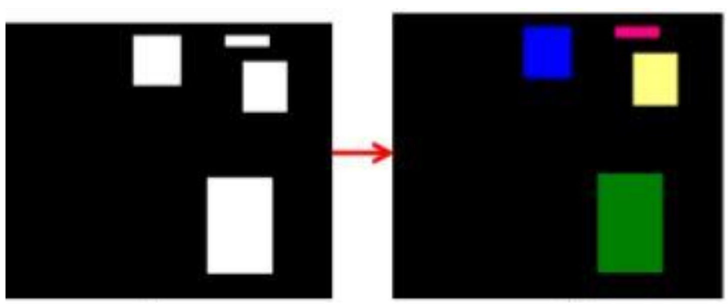
The second emphasis isolated a couple of articles for a similar area appeared in Figure 7.a and disposed in fake distinguished locales. While third emphasis is adequate in view of the fact that no further division should be possible, the other problem is the way to decide the quantity for adequate emphases just before providing a precise division.

Essentially the framework is doing division till no more division is accessible, and in this manner the strategy has ended up being adaptable and versatile to whatever exceptional cases displayed. At long last this self-created strategy has turned out to be a solid division system with exceptionally great outcomes and with no compelling reason to guarantee protest availability before managing division.

4.1.2.2 Object labeling

With a specific end goal to monitor the moving items, marking is a fundamental procedure. This is on the grounds that each protest must be spoken to by a one of a kind name while remembering that the question should safeguard its name without any alteration in view of the fact that the minute enters the view at outline F0 until leaving that view at outline Fn.

The division procedure which was done in the phase had promised us an arrangement for very much isolated districts speaking to the items. This is basically since every district speaks to the question then every area must be given an extraordinary mark and safeguard it until the protest exit from the view. Figure 4.8.a illuminates the yield of a division procedure; unmistakably those locales speaking to the articles are very much isolated. At Figure 4.8.b naming includes given every pixel inside a similar district a comparing name cleared up by specific shading.



(a) Before labeling (b) After labeling

Figure 4.8: Labeling operation

4.1.2.3 Centre extraction

In the following stage the question must be arranged. However, in improvement problem, we found the following fact; there is no compelling reason to follow the whole protest with the pixels sequence, then an engaging point speaking will be required to the question.

Just this point is the protest focus; it speaks to the entire question and can be followed and mapped effectively. In the following area, we examine in points of interest how might we track the inside and amend its mark at some extraordinary cases keeping in mind the end goal to safeguard the uniqueness of naming. For a similar question Figure 4.9 demonstrates the focal point of each protest which we will track at the following stage.

4.1.3 Speed calculation

Presently in the wake of following each protest in video the casing number witch the question came in the video's view at (Fr0) could be spared, while the casing number of leaving the video's view by the question is at (FrN), the velocity of that point count through figuring the quantity for edges devoured when the question go through a view and in view of the fact the term of every edge which have been removed from the video Casing Rate is know by us in this way we can compute the aggregate time which has been taken through the protest could be computed and go through the entire view. Where "T" expresses the full time which is taken through the item to go through the view, while TF represents the length for single frame and N is the entire frames number. Generally the equation to calculate the speed is given by :

$$T = \Delta t = (N * TF) \tag{4.4}$$

$$\text{Speed} = d / (tn - t0) = d / \Delta t \tag{4.5}$$

However, the moved items velocity could be registered. In the midst of the accompanying stage, this system could be assisted in finding this velocity through the structure which has secured a couple of information about each inquiry with a particular true objective. In any case name Î the name that the challenge takes in the wake of stamping undertaking and right names movement. Second Fr0, FrN. Third picture got picture to the inquiry if the picture was at the point of view convergence. Fourth data, the time of capturing the picture. In the wake of figuring speed, the system confirm whether it is manhandling the pre-described speed bind directed by the customer in the midst of the structure game plan, when it slights the boundary of this velocity after that the structure memorizes all inquiry information including the image, velocity, date and time) then the system exempts these information from the storage unit memory , in other word, every similarly name is exempted to make it usable in other defy in a accompanying housings).

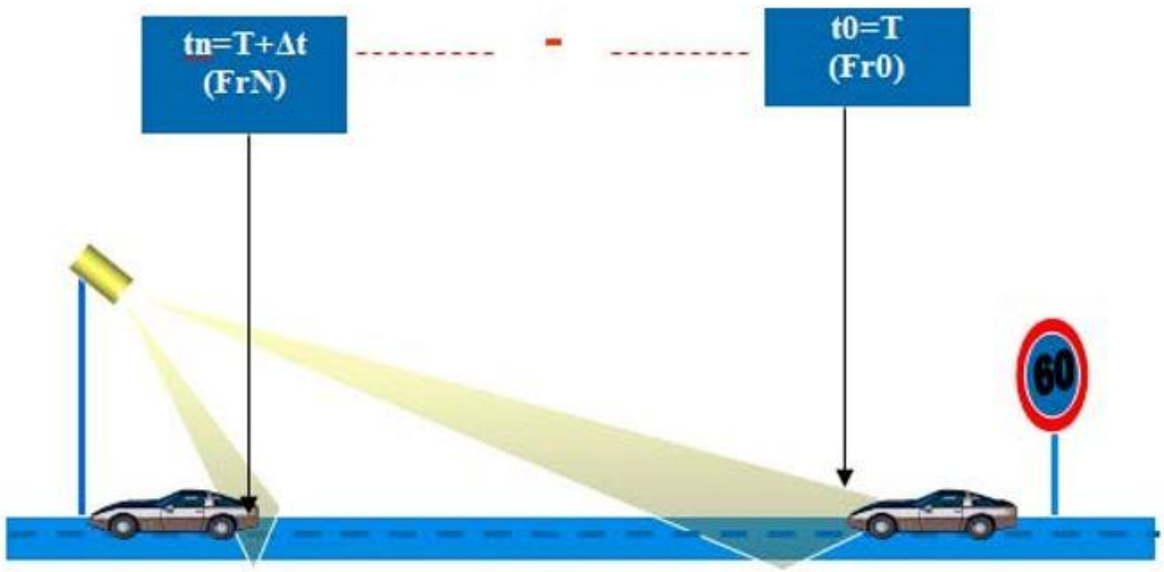


Figure 4.9: Speed measurement model

4.1.4 Capture car image

The position that is preferred to get a photograph through extraordinary assurance to the inquiry suppose that if the dissent is at the convergence point of a view, thusly when the problem is discussed around the convergence point of the image; the structure registers the actual packaging as the dissent got image. There is a broad assortment of estimations that is interested in enhancing the concept of any photo shot from a video. This enhancement is achieved through getting different successive edges (checking the goal image frame that should be updated) from the captured video stream or stream of images. The new obtained edge after enhancement is then submitted with higher quality over the first anyway it needs the video stream to have a high edge rate remembering the ultimate objective to get the edges unreasonably close from each other and this framework is called video change.

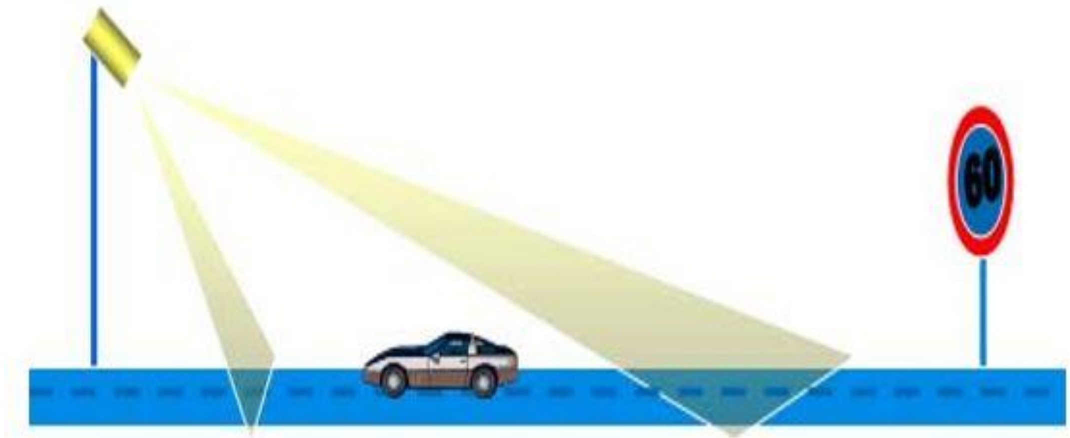


Figure 4.10: Car image capturing model

Subsequent to catching the photo, the framework denotes the focused on question in the casing keeping in mind the end goal to separate amongst it and other moving articles inside the scene.

CHAPTER 5

SYSTEM ANALYSIS

5.1 Implementation the Algorithm

Proposed algorithm was implemented in a script using MATLAB. The flow chart shown in Figure 5.1 below explains the proposed algorithm.

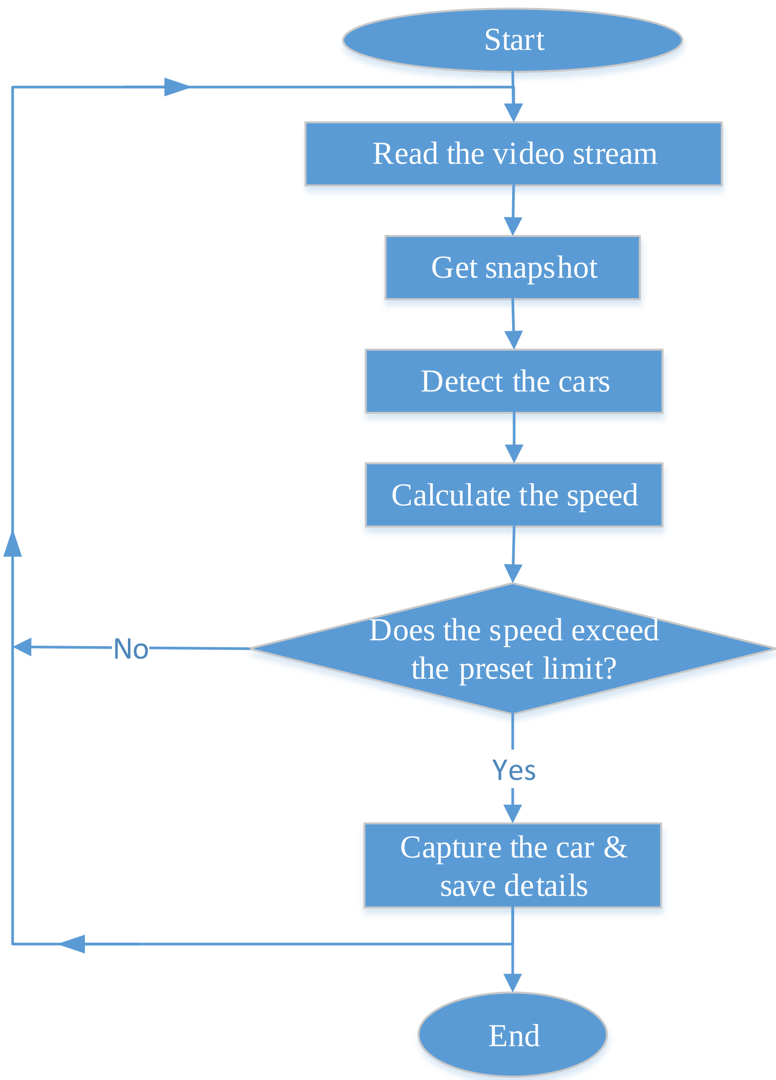


Figure 5.1: Flowchart of the proposed algorithm

First step we input the video into MATLAB then get snapshot from that video. Second step process the image to detect the cars that appear on it. Finally calculate the speed of car according to distance that the car passed and the duration of passing that time. The Figure 5.2 below represents the detailed steps of the work.

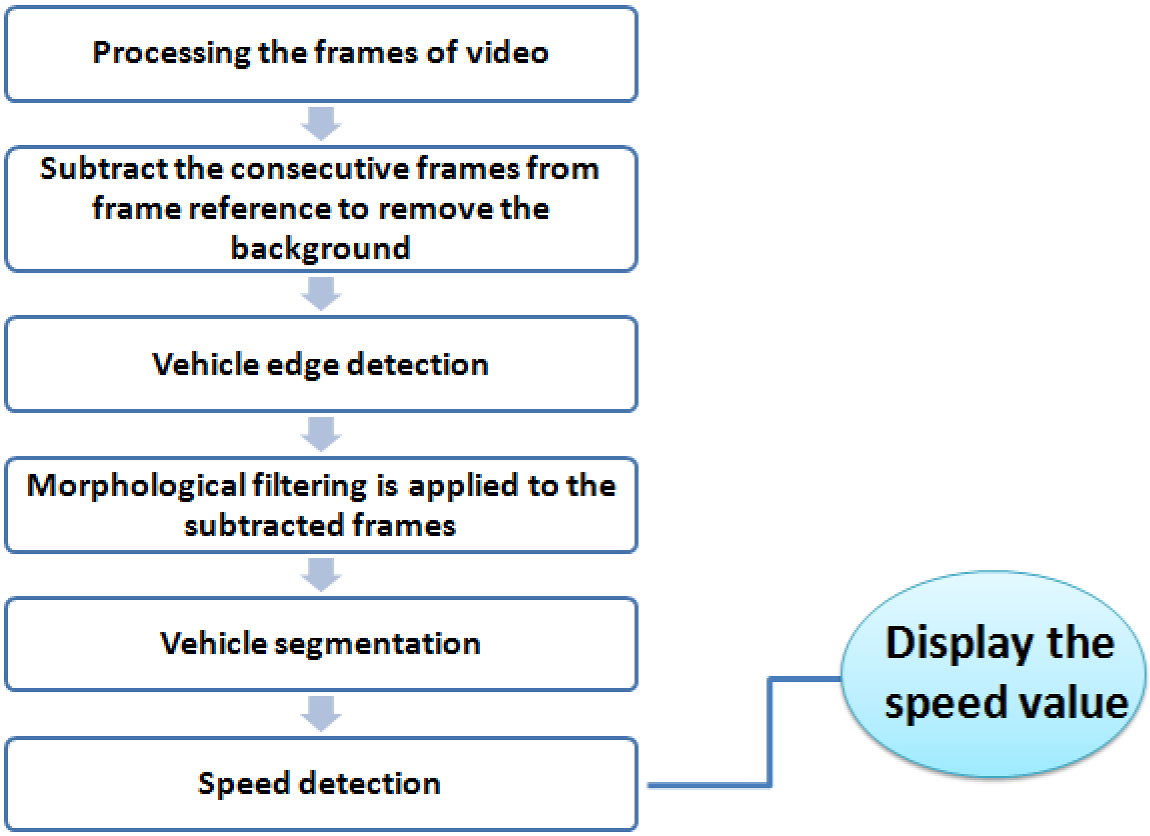


Figure 5.2: Detailed steps of the work

5.2 Graphical User Interface (GUI)

Implementation of algorithm using only script or function into MALTAB is not make the idea clear especially when use video processing, so for under this circumstances I implement the algorithm into MATLAB graphical user interface to show the results.

The Figures below show the detection of the car in steps.

Figure 5.3: The original image

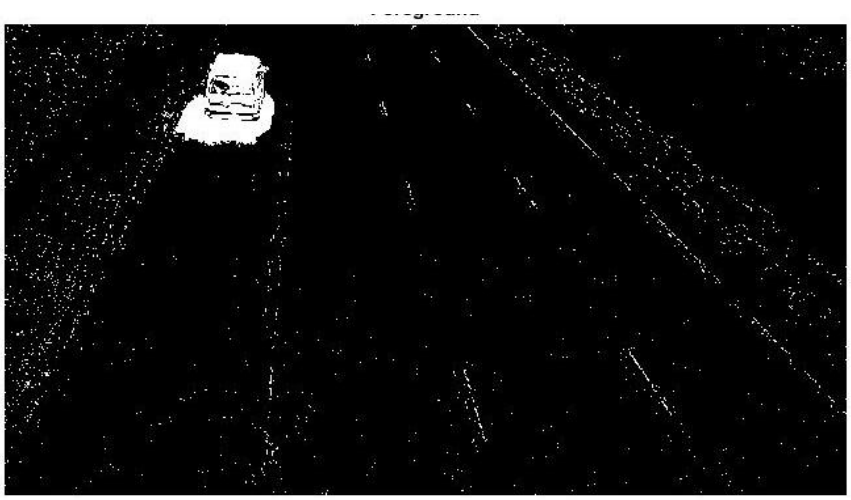


Figure 5.4: Foreground image

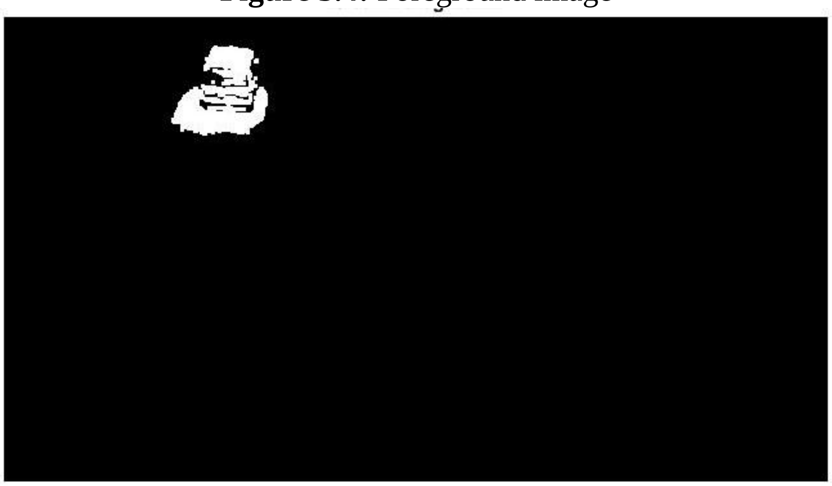


Figure 5.5: Clean Foreground image

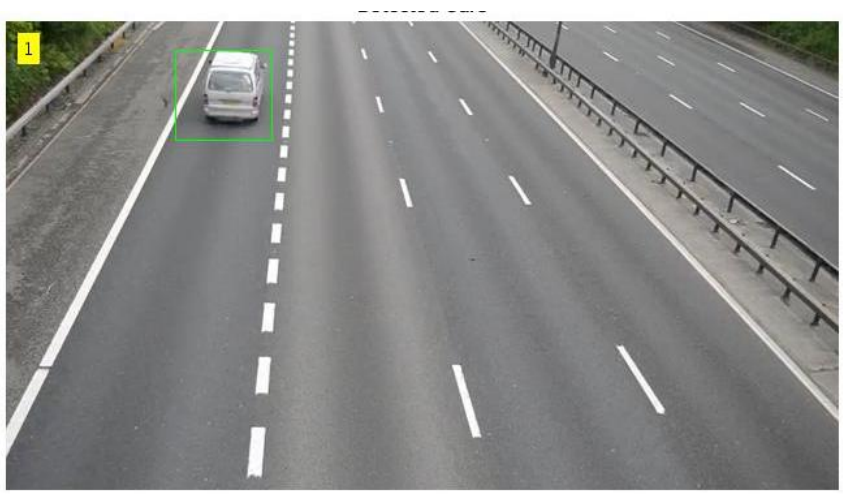


Figure 5.6: Labeling the detected car and show the number of the cars

After detection of the cars the calculation of speed will start considering two different factors. The first factor is the position of the car, position of the car means the car localize in specific track on the street; in our case there are four tracks. The speed of car will be calculated then it will appear on the top of its track. The number of cars is shown in the left corner of the video. See Figure 5.7

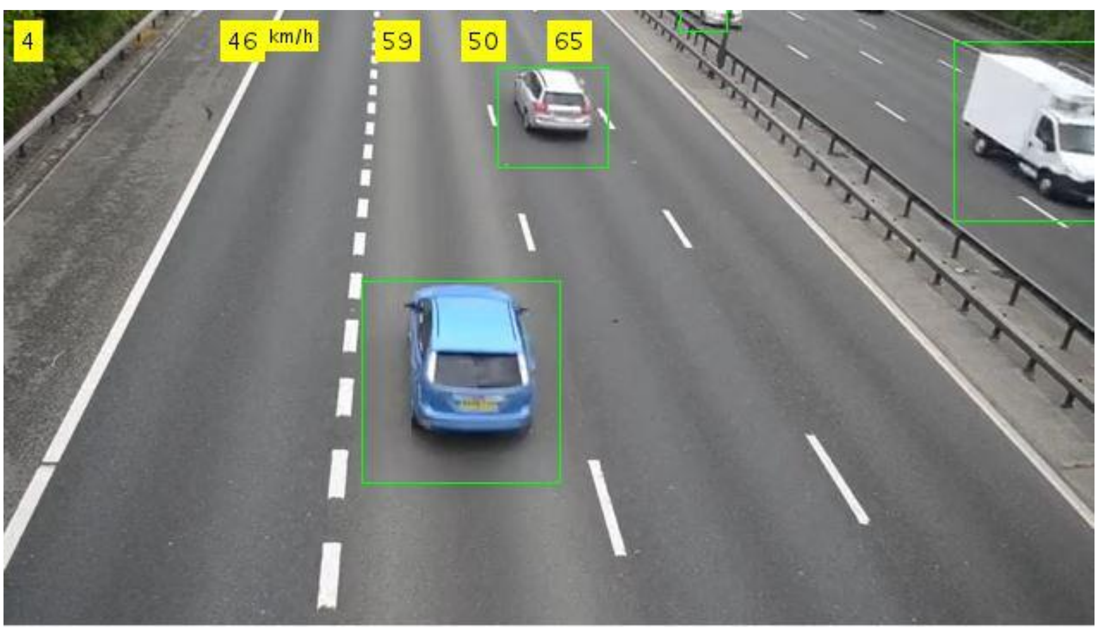


Figure 5.7: Measuring the speed of the car

The car the move with speed more than 60 the program will capture it and save the images into the file considering the number of it and the track of the car. See Figure 5.8 below showing the car number along with its actual speed. The first car on the left is given the number 1 with speed of 67km/h.

Figure 5.8: The saved images of the high speed car in the first track

5.3 Error Evaluation Procedure and Calibration Factor

Calibration tests are organized such that the performance of the system with different configuration parameters can be compared to each other.

The first calibration test is to optimize the parameters to increase the accuracy of the detection, that test consider three different parameters the first parameter is the value of threshold and the second parameter is the value for morphological filter that used to remove noise and the third parameter is the accuracy of the detection. Table 5.1 shows the relation between the three parameters.

Table 5.1: Parameters analysis for detection

Value of Threshold	Morphological Filter value	Actual speed (km/h)	Calculated speed (km/h)	Accuracy
15	1	65	26	40%
20	1	65	22.7	35%
25	1	65	28.6	44%
30	2	65	37.8	59%
40	3	65	57.8	89%
45	3	65	50.7	78%
45	4	65	48.75	75%
50	4	65	40.3	62%

The accuracy of detection calculated according to the comparison the human decision and the result of the program. The accuracy is given according to the formula:

$$accuracy = \frac{calculated\ speed}{actual\ speed} * 100\% \qquad (5.1)$$

The second calibration test is to optimize the parameters to increase the accuracy of the measurement the speed of the car, that test consider three different parameters the first parameter is the distance that the car passed and the second parameter is the execution time of processing and the third on is the accuracy of the speed measurement. Table 5.2 shows the relation between the three parameters.

Table 5.2: Parameters analysis for speed measurement

Distance	Execution Time	Actual speed (km/h)	Calculated speed (km/h)	Accuracy
3 meters	0.051	65	47.4	73%
3.5 meters	0.061	65	39.6	61%
4 meters	0.063	65	33.8	52%
5 meters	0.069	65	31.8	49%
5.5 meters	0.072	65	42.2	65%
6.5 meters	0.062	65	57.2	88%
7 meters	0.068	65	46.1	71%
8 meters	0.058	65	50.7	78%

The accuracy of speed measurement calculated according to the comparison the speed of the car using proposed algorithm with the real speed of the car.

CHAPTER 6
CONCLUSIONS

The increasing number of vehicles using the roads around the world has encouraged governments to be concerned about the security in the roads. Traffic lows were created to control the traffic flow all the time and to ensure the highest degrees of security. One of the most concerns of countries is the speed control of different vehicles flowing in the street. In the past, human traffic police were supposed to carry out the tasks of traffic control. However, the need for automated traffic control system with high accuracy and low cost has become more and more demanded.

Automated traffic control includes the use of traffic lights and speed measurement devices. This work is concerned is mainly concerned by the development of an algorithm that has the ability to detect moving vehicles in the street and measure their speeds. The algorithm will be also in charge of detecting the over speed moving cars and recording their images.

The proposed system mainly depends on the processing of images used to improve the video and split frames so that the cars can be adjusted and speed can be calculated. Main idea of the algorithm is to split the captured real time videos into frames of pictures at constant periods of time. The frames will be processed to detect cars in each frame and find the time between these frames. The speed of cars is then found by dividing the distance between frames by the time that separates them.

Speed measurement control using image processing that I propose overcomes all the limitations of the in use techniques. Using of automatic speed measurement control will increase the number of accident especially in highway road. This technique avoids such issue since it depends on real time processing and can determine the true value of speed. Upon comparison of various filtering techniques such as mean filter, median filter and Gaussian filter, it was inferred that Gaussian filter is most efficient for our purpose. The proposed methodology is the simplest and there is no need to use expensive sensors and hardware. The accuracy of the vehicle detection is 89% and the accuracy of the speed measurement is 88%. The accuracy of speed measurement calculated according to the comparison the speed of the vehicle using proposed algorithm with the real speed of the vehicle. Output of GUI clearly indicated some expected results. It showed the speed of each vehicle on the top of its track and represents the number of detecting vehicle.

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APPENDIX

MATLAB CODE

```
foregroundDetector = vision.ForegroundDetector('NumGaussians', 3, ...
'NumTrainingFrames', 60);
videoReader = vision.VideoFileReader('v1.avi');
for i = 1:100
    frame = step(videoReader); % read the next video frame
    frame = imgaussfilt(frame);      % apply 2D gaussian filter for images
    foreground = step(foregroundDetector, frame);
end
Figure; imshow(frame); title('Video Frame');
Figure; imshow(foreground); title('Foreground');
se = strel('square', 3);
filteredForeground = imopen(foreground, se);
Figure; imshow(filteredForeground); title('Clean Foreground');
blobAnalysis = vision.BlobAnalysis('BoundingBoxOutputPort', true, ...
'AreaOutputPort', false, 'CentroidOutputPort', true, ...
'MinimumBlobArea', 150);
[centroids,bbox] = step(blobAnalysis, filteredForeground);
result = insertShape(frame, 'Rectangle', bbox, 'Color', 'green');
numCars = size(bbox, 1);
result = insertText(result, [10 10], numCars, 'BoxOpacity', 1, ...
'FontSize', 14);
Figure; imshow(result); title('Detected Cars');
videoPlayer = vision.VideoPlayer('Name', 'Detected Cars');
videoPlayer.Position(3:4) = [650,400];  % window size: [width, height]
se = strel('square', 3); % morphological filter for noise removal
x1=1;
x2=1;
x3=1;
x4=1;
speed_limit=65;
    speed1=0;
    speed2=0;
    speed3=0;
    speed4=0;
    speed1_p=0;
    speed2_p=0;
    speed3_p=0;
```

```
    speed4_p=0;
    iname1=1;
    iname2=1;
    iname3=1;
    iname4=1;
while ~isDone(videoReader)
tic
frame = step(videoReader); % read the next video frame

% Detect the foreground in the current video frame
foreground = step(foregroundDetector, frame);

% Use morphological opening to remove noise in the foreground
filteredForeground = imopen(foreground, se);

% Detect the connected components with the specified minimum area, and
% compute their bounding boxes
    [centroids,bbox] = step(blobAnalysis, filteredForeground);
centroid = step(blobAnalysis, filteredForeground);

% Draw bounding boxes around the detected cars
result = insertShape(frame, 'Rectangle', bbox, 'Color', 'green');
    [a,cc]=size(centroid);
numCars = size(bbox, 1);
    n=9*3600;
    n=n/1000;
if(numCars>0)
fori=1:a
        x=centroid(i,1);
        y=centroid(i,2);
% find the time
if(y>240 && y<275)
if x>0&&x<200
if(x1==1)
                a1=clock;
x1=0;
end
end
if x>200 && x<350
if(x2==1)
                a2=clock;
x2=0;
end
end
if x>360&&x<470
if(x3==1)
```

```
            a3=clock;
x3=0;
end
end
if x>470&&x<580
if(x4==1)
            a4=clock;
x4=0;
end
end
end
% find the speed
if(y<80&&y>60)
if x>0&& x<215
if(x1==0)
            b1=clock;
            t1=etime(b1,a1);
            speed1=n/t1;
            speed1=speed1*1.2;
x1=1;
if(speed1>140||speed1<30)
               speed1=speed1_p;
end
end
end
if x >215&&x<292
if(x2==0)
            b2=clock;
            t2=etime(b2,a2);
            speed2=n/t2;
            speed2=speed2*1.2;
x2=1;
if(speed2>140||speed2<30)
               speed2=speed2_p;
end
end
end
if x>292&&x<360
if(x3==0)
            b3=clock;
            t3=etime(b3,a3);
            speed3=n/t3;
            speed3=speed3*1.2;
x3=1;
if(speed3>140||speed3<30)
               speed3=speed3_p;
```

```
end
end
end
if x>360&&x<430
if(x4==0)
            b4=clock;
            t4=etime(b4,a4);
            speed4=n/t4;
            speed4=speed4*1.2;
x4=1;
if(speed4>140||speed4<30)
               speed4=speed4_p;
end
end
end
end
end
end
% for i=1:a(1)
%    m=text(centroid(i,1)+50,centroid(i,2), strcat('X: ', centroid(i,1),'    Y: ',centroid(i,2)));
% end
% Display the number of cars found in the video frame
numCars = size(bbox, 1);
result = insertText(result, [10 10], numCars, 'BoxOpacity', 1, ...
'FontSize', 14);
result = insertText(result, [130 10], round(speed1), 'BoxOpacity', 1, ...
'FontSize', 14);
result = insertText(result, [155 10], 'km/h', 'BoxOpacity', 1, ...
'FontSize', 10);
result = insertText(result, [220 10], round(speed2), 'BoxOpacity', 1, ...
'FontSize', 14);
result = insertText(result, [270 10], round(speed3), 'BoxOpacity', 1, ...
'FontSize', 14);
result = insertText(result, [320 10], round(speed4), 'BoxOpacity', 1, ...
'FontSize', 14);
step(videoPlayer, result);  % display the results

%%%  save the images
if(speed1_p~=speed1)
if(speed1>speed_limit)
      iname1_s=int2str(iname1);
      speed1_s=int2str(speed1);
      frame1 = step(videoReader);
      speed1_p=speed1;
FileName=['C:\Users\abdulkader\Desktop\High speed cars\First track\' iname1_s '_' speed1_s
'.jpg'];
```

```
imwrite(frame1,FileName,'jpg')
        iname1=iname1+1;
end
end
if(speed2_p~=speed2)
if(speed2>speed_limit)
        iname2_s=int2str(iname2);
        speed2_s=int2str(speed2);
        frame1 = step(videoReader);
        speed2_p=speed2;
FileName=['C:\Users\abdulkader\Desktop\High speed cars\Second track\' iname2_s '_'
speed2_s '.jpg'];
imwrite(frame1,FileName,'jpg')
        iname2=iname2+1;
end
end
if(speed3_p~=speed3)
if(speed3>speed_limit)
        iname3_s=int2str(iname3);
        speed3_s=int2str(speed3);
        frame1 = step(videoReader);
        speed3_p=speed3;
FileName=['C:\Users\abdulkader\Desktop\High speed cars\Third track\' iname3_s '_' speed3_s
'.jpg'];
imwrite(frame1,FileName,'jpg')
        iname3=iname3+1;
end
end
if(speed4_p~=speed4)
if(speed4>speed_limit)
        iname4_s=int2str(iname4);
        speed4_s=int2str(speed4);
        frame1 = step(videoReader);
        speed4_p=speed4;
FileName=['C:\Users\abdulkader\Desktop\High speed cars\Fourth track\' iname4_s '_'
speed4_s '.jpg'];
imwrite(frame1,FileName,'jpg')
        iname4=iname4+1;
end
end
ff=toc
end
release(videoReader); % close the video file
```