AN INTELLIGENT TRAFFIC CONTROLLER SYSTEM BASED ON VEHICLE DETECTION AND COUNTING

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AN INTELLIGENT TRAFFIC CONTROLLER SYSTEM BASED ON VEHICLE DETECTION AND COUNTING

WAN NADIA SYAKIRA BINTI WAN ZULKIFLI

This report is submitted in partial fulfillment of the requirements for the Bachelor of Computer Science (Artificial Intelligence)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2017

DECLARATION

I hereby declare that this project report entitled

AN INTELLIGENT TRAFFIC CONTROLLER SYSTEM BASED ON VEHICLE DETECTION AND COUNTING

is written by me and is my own effort and that no part has been plagiarized without citations.

STUDENT :______________________________ Date : 14/8/2017

(WAN NADIA SYAKIRA BT. WAN ZULKIFLI)

SUPERVISOR :______________________________ Date : 14/8/2017

(PM DR ASMALA BIN AHMAD)

DEDICATION

I dedicate my final year project report to my family and friends. To my supervisor, PM Dr. Asmala Ahmad for guiding and helping me to finish up this project. I would like to express deep gratitude to my beloved parents for a life-long love and affection. They have been very supportive and encouraging in completion of my thesis and throughout the years of my studies. They are the reason why I strive to make this project successful. On top that, I also would like to dedicate this report to my close friends and family who have been very supportive throughout the project development.

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I would like to greatly thank the contribution of the following individuals in helping me throughout the project. Firstly is my supervisor, PM Dr. Asmala Ahmad who have given me a lot of encouragement, guidance and support from the initial to the final level of my project which successfully developed an understanding of the project in me. Besides that, I also would like to thank my parents and friends for being so supportive throughout the project and helped me a lot in term of moral support. They were so helpful where my friend accompanied me to the study area. Lastly, I would like to thank my class peer for their cooperation and camaraderie and to all those who supported me in any aspect throughout the project.

ABSTRACT

The main reason why traffic congestion has become a serious issue especially in the modern cities is the increase in the population of the large cities that subsequently raise vehicular travel, which creates congestion problem. Manually controlling a traffic light in big cities and the whole framework cost too much manpower. The incompetency of traffic police play a part in controlling traffic physically as well. Besides, the programmed traffic control uses timer control each stage. This causes the green light in the empty road being wasted. Traffic clog additionally occurred while utilizing the electronic sensors for controlling the traffic. Every one of these downsides should be dispensed with by utilizing image processing. Therefore, the main purpose of this project is to controlling the traffic light by image processing. The vehicles are detected by the system through video instead of using electronic sensors embedded in the pavement. The video will be captured by using a camera to collect the data and also done image processing analysis. Next is to purpose a vehicle counting and detection method. Image processing method will be applied in this analysis in order to gain that information to improving the management of traffic. The video taken from the camera will be done the image processing by MATLAB software. The method used for the detection are foreground detection and morphology. The knowledge and skill that was found during carried out this project will be useful in developing an efficient traffic control system. This method is efficient for large traffic congestion where only requires the processing of the image of traffic compared to traffic light that was used nowadays. The system is expected able to control the traffic efficiently based on the number of queuing vehicles.

ABSTRAK

Sebab utama mengapa kesesakan lalu lintas telah menjadi satu isu yang serius terutama di bandar-bandar moden adalah peningkatan jumlah penduduk di bandar-bandar besar yang kemudiannya menaikkan perjalanan kenderaan, yang mewujudkan masalah kesesakan. Mengawal lampu isyarat secara manual di bandar-bandar besar dan seluruh kos rangka kerja mempunyai kos tenaga manusia yang terlalu banyak. Ketidakcekapan polis trafik memainkan peranan dalam mengawal lalu lintas secara fizikal juga. Selain itu, kawalan trafik yang diprogramkan menggunakan pemasa mengawal setiap peringkat. Ini menyebabkan lampu hijau di jalan yang kosong yang sia-sia. Kesesakan trafik tambahan berlaku semasa menggunakan sensor elektronik untuk mengawal lalu lintas. Setiap satu daripada kelemahan ini perlu diketepikan dengan menggunakan pemprosesan imej. Oleh itu, tujuan utama projek ini adalah untuk mengawal lampu isyarat dengan pemprosesan imej. Kenderaan itu dikesan oleh sistem melalui video dan bukannya menggunakan sensor elektronik tertanam di kaki lima. Video tertangkap dengan menggunakan kamera untuk mengumpul data dan analisis pemprosesan imej juga dilakukan. Seterusnya adalah untuk tujuan kiraan kenderaan dan kaedah pengesanan. Kaedah pemprosesan imej akan digunakan dalam analisis ini untuk mendapatkan maklumat tersebut untuk meningkatkan pengurusan lalu lintas. Video yang diambil dari kamera akan dilakukan pemprosesan imej dengan perisian MATLAB. Kaedah yang digunakan untuk pengesanan adalah pengesanan latar depan dan morfologi. Pengetahuan dan kemahiran yang telah dijumpai semasa menjalankan projek ini akan berguna dalam membangunkan sistem kawalan trafik yang cekap. Kaedah ini berkesan untuk kesesakan lalu lintas yang besar di mana hanya memerlukan pemprosesan imej trafik berbanding lampu isyarat yang digunakan pada masa kini. Sistem ini dijangka dapat mengawal lalu lintas yang cekap berdasarkan bilangan kenderaan beratur.

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LIST OF ABBREVIATIONS

UAV	-	Unmanned Aerial Vehicle
LiDAR	-	Light Detection and Ranging
TIR	-	Thermal Infrared
EO	-	Electro optical
ITS	-	Intelligent Transportation Systems
CCD	-	Charged Coupled Device
GMM	-	Gaussian Mixture Models
SCATS	-	Sydney Coordinated Adaptive Traffic System
SCOOT	-	Split Cycle Offset Optimization Technique
FPV	-	First Person View
GCS	-	Ground Control System
GPS	-	Global Positioning System
IMU	-	Inertial Measurement Unit

LIST OF ATTACHMENTS

CHAPTER I

INTRODUCTION

1.1 Project Background

Transportation has for quite some time been an essential path for individuals to head out starting with one place then onto the next. As we probably am aware, in the middle of all types of transport, land transport has the most astounding number of clients as more down to earth and sensible cost. By the expansion in populace on the planet, the quantity of transport especially autos, transports and trucks have likewise expanded definitely in all parts of the world. In spite of the fact that it gives a decent impression to the economy, yet the disappointment of good traffic management, these vehicles can bring about negative impacts, particularly to develop nations like Malaysia. The quantity of vehicles out and about expands step by step in this way for the best usage of existing street limit, it is imperative to deal with the movement stream proficiently. Activity clog has turned into a difficult issue particularly in the present day urban communities. The primary reason is the expansion in the number of inhabitants in the substantial urban communities that in this manner raise vehicular travel, which makes blockage issue. Because of the activity blockages there is additionally an expanding expense of transportation due to wastage of time and furthermore additional fuel utilization. Other than that, congested roads additionally make numerous other basic issues and issues which straightforwardly influence the human routine lives. Over the top number of action on avenues and despicable controls of that development can cause activity blockage. In this manner, automated development area system is required to run the improvement smooth and safe, which will at last lead us towards proper examination of action, honest to goodness adjustment of control organization and scattering of controlling signs.

There are loads of methods can be proposed to design an intelligent traffic system. For this project, image processing technique is proposed to control the traffic signal on the road of Malacca Central, in which they initially input the video captured. The system will detect and count the number of vehicle. By the outcome get, it will help in sector of traffic in management.

According to PB Farrradyne, use of unmanned aerial vehicles (UAVs) in data collection are dramatically improve traffic management (PB Farradyne, 2005). UAVs also captured aerial images suitable for traffic surveillance and data collection (Edward D. McCormack, 2008). In this manner, UAV remote sense will be utilized to catch image successions, gather the information and furthermore done image processing examination. Image processing is a superior procedure to control the state change of the traffic light. It demonstrates that it can diminish the movement clog and stays away from the time being squandered by a green light on a vacant street. Other than that, it is likewise more dependable in evaluating vehicle nearness since it utilizes genuine traffic images. Other than that, it capacities a great deal more superior to those frameworks that depend on the location of the vehicles' metal substance. For this project, the normal outcome will in light of the image information that are gathered from the digital camera to arrange the amount of vehicle on certain territory to foresee the traffic circumstance.

1.2 Problem Statement

In the mannual controlling framework we require more labor. As we have poor quality of traffic police, we can't control the traffic physically in all range of a city. Along these lines, we require a superior solution for control the traffic. Besides, programmed traffic controlling a traffic light uses timer for each stage. Utilizing the electronic sensors is an another route so as to detect vehicles and deliver flag that to this technique the time is being squandered by a green light on a void street. Traffic clog additionally occured while utilizing the electronic sensors for controlling the traffic. Every one of these downsides should be dispensed with by utilizing image processing.

1.3 Objective

This project embarks on the following objectives:

1. To propose a vehicle detection and counting method using image processing techniques.
2. To develop an intelligent traffic controller system based on vehicle detection and counting.
3. To evaluate the performance of the method and system.

1.4 Scopes

The scope of the examination is apportioned into three section which are software scope, data scope, area of study scope and user scope.

1.4.1 Software Scope

Primarily there is just a single software tools being utilized as a part of this review which is MATLAB R2017a for analysis and classify the vehicle from the video sequence.

1.4.2 Data Scope

The data that is used for this study is the video that taken from the digital camera. Digital camera was used for this project because digital camera is the best device to get great information. A digital camera records and stores photographic pictures in digital shape. Numerous present models are additionally ready to capture sound or video, notwithstanding still pictures. Capture is generally refined by utilization of a photosensor, utilizing a charged coupled device (CCD). These put away pictures can be transferred to a computer quickly or put away in the camera for to be transferred into a computer or printer later. Pictures may likewise be filed on a photographic compact disc or external hard disk. Figure 1.1 show the image of digital camera.

Figure 1.1: Image of Digital Camera (ePHOTOzine, 2016)

1.4.3 Area of Study Scope

Malacca, Malaysia was picked as my concentration zone of study. I found that Malacca pronounced that its notorious traffic bottlenecks had achieved a plague organize and had issued a mandate to all important organizations to promptly discover an answer for resolve the blockages, particularly amid the ends of the week.

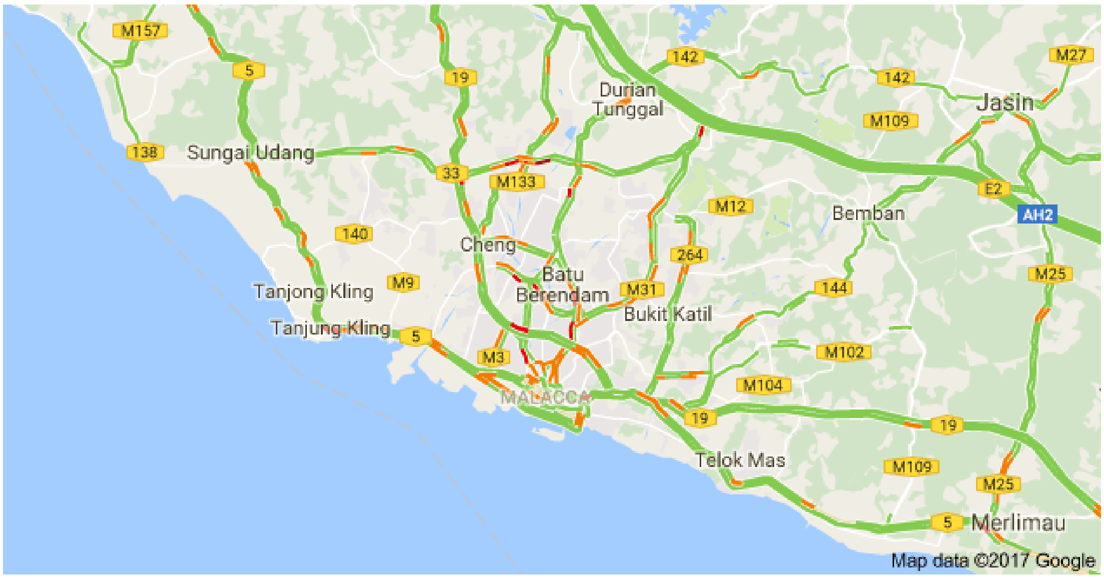

Figure 1.2: Current traffic for Malacca, Malaysia (Google Maps, 2017)

1.4.4 User Scope

The results of this venture will be helpful for the researchers, students or lecturers and all relevant agencies. The output will be utilized as research and reference materials in future reviews. The proposed method and output will be profitable in the midst of the teaching and learning process. The relevant agencies can likewise utilize the aftereffect of examination to decide the actions to resolve the congestions. This could prompt to comfort of relevant agencies analysers to anticipate the evaluated traffic congestion.

1.5 Project Significance

The knowledge and skill that was found during carried out this project will be useful in developing an efficient traffic control system. This technique is proficient for extensive activity clog where just requires the preparing of the picture and video of movement compared to traffic light that was used nowadays. The system is expected able to control the traffic efficiently based on the number of queing vehicles. The study will provide recommendation for improving the currently develop system. As the result of this project is important to use by researcher and relevant agencies, this project must be able to analyse the vehicle detection and counting. Digital camera innovation can spare time as it is an approach to get the data about an activity or vehicle without reaching the protest. This task result likewise can be an examination reference later on ponders.

1.6 Expected Output

Based on the project, the expected output would be as the following:

1. The knowledge and understanding on the technique to count and detect vehicle using image processing.
2. A system for controlling traffic based on vehicle detection and counting.
3. Performance measure for the system and system accuracy.

1.7 Conclusion

In conclusion, this project will be classifying the vehicle detection and counting based on the digital camera video and image. Image processing and video processing technique will be utilized for this analyzation. The video taken will be analyse using the system. This aftereffect of venture will be important for researchers, students or lecturers and relevant agencies. As for Chapter 1, it has discussed on the background of the study. To accomplish the goals in Chapter 1, the study process will be clarified in the next following chapters.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

A literature review is an inquiry and assessment of the accessible literature in the given subject or picked topic region. It reports the state of the art regarding the subject or topic that are writing about. Other than that, literature review also can be deciphered as a review of a theoretical achievement. It is a review of the synopsis of past analysts on the related theme for this venture. In my project, literature reviews are a staple as this review guides me in proposing a strategy with wide background study. Through the review of the academic literature pertinent to my venture, this venture will be helped with composing the investigation to get the clearer perspective of the venture created.

In this section, the literature review is centered more around results and examinations of the exploration papers and journals. Different trusted sources and references are taken from trusted research papers and journals being utilized for this venture. The fundamental reason for this literature review and investigation is a direction of the venture with reference to substantial and dependable sources. An investigation is likewise an essential component in my venture study as it talks about and recognizes the issue experienced with customary method or methodology that is as of now being utilized.

2.2 Review of Vehicles

(Wikipedia, 2017) stated that vehicle is a mobile or portable machine that transports people or cargo. It is a thing used for transporting people or goods, especially on land, such as a car, truck, or cart. Common vehicles include wagons, bicycles, motor vehicles (motorcycles, cars, trucks, and buses), railed vehicles (trains, trams), watercraft (ships, boats), aircraft and spacecraft. Land vehicles are characterized extensively by what is utilized to apply steering and drive forces against the ground: wheeled, tracked, railed or skied. Table 2.1 shows different variety of vehicles; buses, automobiles, bicycle and motorcycle.

Table 2.1: Varieties of Vehicle

Type	Vehicle	Characteristic
Buses	 **(Discuz, 2015)**	A common form of vehicles used for public transport.
Automobiles	 **(The Rocket, 2011)**	Among the most commonly used engine-powered vehicles.
Bicycle	 **(Wikipedia, 2017)**	The most common model of vehicle in the world.

Motorcycle	 **(Gurunsakura.blogspot, 2012)**	Motorcycle in Malaysia.

The number of vehicles on the road in Malaysia is increasing every year. Vehicles such as cars has been introduced since 1985. Based on Figure 2.1, table released on 2015 by Ministry of Works shows the traffic composition (%) by type of vehicle at 14 selected stations, Malaysia.

JADUAL 1.14 : KOMPOSISI TRAFIK (%) MENGIKUT JENIS KENDERAAN DI 14 STESEN TERPILIH, MALAYSIA, 2015
Table 1.14 : Traffic Composition (%) by Type of Vehicle at 14 Selected Stations, Malaysia, 2015

BIL *No*	STESEN *Station*	LOKASI *Location*	16 JAM TRAFIK *16 Hours Traffic*	JENIS KENDERAAN *Type of Vehicle*					
				KERETA/ TEKSI *Car/ Taxi*	LORI KECIL *Light Lorry*	LORI SEDERHANA *Medium Lorry*	LORI BESAR *Heavy Lorry*	BAS *Bus*	MOTOSIKAL *Motorcycle*
				SEMENANJUNG MALAYSIA *Peninsular Malaysia*					
1	JR 204	Johor Bahru - Kulai	108,858	72.9	7.2	4.0	3.2	2.3	10.4
2	JR 501	Johor Bahru - Endau	14,672	53.9	6.5	5.6	3.2	0.8	30.1
3	NR 501	Seremban - Kuala Lumpur	11,870	59.8	8.9	7.4	4.7	0.5	18.6
4	PR 115	Butterworth - Taiping	42,148	56.5	6.3	6.4	2.5	0.7	27.6
5	AR 301	Ipoh - Kampar	30,592	65.1	7.5	8.1	4.5	1.1	13.7
6	KR 501	Alor Setar - Sungai Petani	19,854	57.0	6.2	6.5	4.2	0.5	25.6
7	CR 805	Kuantan - Maran	6,369	59.5	11.8	8.8	6.6	0.6	12.8
8	CR 902	Persimpangan Bukit Iban - Rompin Di Lebuh Raya Kuantan - Segamat	9,985	54.9	19.2	7.0	7.5	0.5	10.9
9	TR 402	Kuala Terengganu - Kuantan	24,887	68.1	6.8	3.0	0.7	0.7	20.7
10	DR 802	Kota Bharu - Kuala Krai	23,345	54.7	19.2	7.5	2.8	0.7	15.1
				SABAH					
11	HR 201	Kota Kinabalu - Papar	15,786	56.3	26.6	6.3	3.6	0.8	6.4
12	HR 501	Tawau - Semporna	11,508	32.6	37.2	12.9	7.4	1.2	8.7
				SARAWAK					
13	SR 103	Kuching - Serian	34,874	50.0	15.3	9.3	7.4	0.9	17.0
14	SR 402	Bintulu - Miri	7,452	35.2	37.1	7.0	13.1	1.3	6.3

SUMBER: KEMENTERIAN KERJA RAYA
Source: Ministry of Works

Figure 2.1: Traffic Composition (%) by Type of Vehicle at 14 Selected Stations, Malaysia, 2015 (Ministry of Works, 2015)

2.3 Types of Road

(Wikipedia, 2017) stated that road is a thoroughfare, route, or way on land between two places that has been paved or otherwise improved to allow travel by foot or some form of conveyance, including a motor vehicle, cart, bicycle, or horse. Roads consist of one or two roadways (British English: carriageways), each with one or more lanes and any associated sidewalks (British English: pavement) and road verges. Roads that are available for use by the public may be referred to as parkways, avenues, freeways, interstates, highways, or primary, secondary, and tertiary local roads. Figure 2.2, Figure 2.3, Figure 2.4 and Figure 2.5 below shows different type of roads in Malaysia.

Figure 2.2: A City Street in Malacca (itaxi.my, 2016)

Figure 2.3: Malacca Highway (Wikimedia, 2016)

Figure 2.4: Road with traffic sign at Bandar Hilir Melaka (The Neem webpages)

Figure 2.5: Road after rain (Pexels.com)

2.4 Drones Remote Sensing

Drones remote sensing has been widely used in current technology. This sub topic describes in depth of drones remote sensing. Previous research techniques or procedures will also be discussed.

2.4.1 Review of Unmanned Aerial Vehicle (UAV) or Drones Remote Sensing

An unmanned aerial vehicle (UAV), generally known as a drone, unmanned aircraft system (UAS), or by a few different names, is an aircraft without a human pilot on board. This reduces physical work and you get a more broad field of view. This also does not hamper the normal presences of the overall public making it less complex for them. With exceptional cameras, these gadgets could assemble information and photos of the debris working in a specific locale. It would get clearer recordings of the disaster site without spending a huge amount of money on helicopters. Additionally, the drones, these days, are enduring and can give crisp and clear pictures. Drones have discovered different applications in different territories. They are at no time in the future limited to just military uses and unmistakable associations are as of now placing assets into these contraptions for a swifter and more responsive customer advantage, especially in the case of parcel deliveries (My Drone Lab, 2017).

Other than that, (Vrunal Mhatre *et al.* 2015) stated that First Person View (FPV) is given to pilots for to achieve long separation mission execution alongside image processing for exact information investigation of flight attributes. Alongside this, the telemetry information obtained from Arduino incorporated with sensors viz., GPS, Altimeter, IMU helps the pilot for keeping up enduring flight attributes. The minimal effort general processing boards like Raspberry Pi and Arduino encourages adaptability in implanting different sensors in view of prerequisites of the pilot. Alongside the on-board the telemetry system, the Ground Control System (GCS) gives first individual visual guide on base station. The JavaFx interface is platform independent with components like FPV video streaming in real-time, portrayal of UAV's elevation, orientation and position at each occasion of time. Additionally, the trans-receiver correspondence permits controlling flight attributes from the interface, expanding the extent of utilizations with UAV.

(Lia Reich, 2016) also mention that as high-constancy sensors keep on becoming littler and more conservative, rambles are presently fit for conveying more payload choices than any time in recent memory. With all these particular models, picking the correct one for each remarkable mechanical utilize can feel overpowering. The most ideal approach to manage start is to see the particular needs by first picking the outcome that we require. Once have set up the goals, picking the most fitting sensor will come viably. Better aeronautical information is significantly subject to the idea of data coming into the pipeline. In this manner, they offer a broad assortment of sensors and extensive data examination gadgets that are unparalleled in the present UAV advertise. Table 2.2 below is a brief overview of each sensor available, its industry applications and use cases.

Table 2.2: Overview of drone remote sensing sensors

Models	Overview
Hyperspectral	The completely organized evident and close infrared Hyperspectral Sensor is perfect for little UAV applications. Hyperspectral gives more quick and dirty information content with a capacity to see the subtle conversely with a visual camera. The line checking (push floor brush) sort sensor is perfect for investigate applications to gage the spectrography of the ground.
LiDAR	LiDAR is a more standard reviewing instrument used for making point mists and computerized height models of the ground. The data can be used for plant tallness estimation by contrasting the main come back from the laser when it hits the best purpose of the plant to the last return when it hits the ground. The capacity to invade foliage makes LiDAR remarkable stood out from dormant optical imagers that give stature data just from the haven. The computerized rise models can be more correct stood out from visual sensor based advanced height models, dependent upon the application.

Multispectral	The Multispectral Sensor is a champion among the most frequently used checking frameworks. Like the Hyperspectral Sensor it's ready to see unmistakable light, infrared radiation and bright light. They run in the amount of groups and resolutions, besting out at sub one centimeter for each pixel.
Thermal Infrared (TIR)	Thermal Infrared Sensors can measure and read the surface temperature of land or protests past the extent of human vision. Regardless of the way that the two sensors (a High Determination TIR-H and Radiometric High Determination Warm Sensor) are on a very basic level the same as, a key difference is the High Determination TIR-H sensor yield is straight with temperature.
Visual	Both the Visual Sensor and Upgraded Determination Visual Sensor are high-determination, low-twisting RGB cameras which produces shading symbolism. A vital great position of visual symbolism caught by a UAV is the flying viewpoint of a specific district. It ready to get a winged creatures eye-see high-res picture without contributing extra effort for the vantage point.

2.5 Image Processing and Video Processing

Image processing is the process of images that use mathematical operations by utilizing any type of flag preparing for which the info is a picture, a progression of pictures, or a video, for example, a photo or video outline. The yield of picture preparing may be either a picture or a course of action of characteristics or parameters that identified with the picture. Picture preparing more often than not alludes to advanced picture handling, however optical and simple picture handling additionally are conceivable. In the field of technology, digital images usage is increasing day by day. Digital imaging is used in face recognition, signature recognition as well as intelligent bureaus. These images may be corrupted due to some noise issues. The meaning of denoising is to remove the noise from the signal. It is also known as noise reduction. Noise is an unwanted signal that may occur in the image. The reason behind the noise in image is Imperfect instruments, problems with the data acquisition process, and interfering natural phenomena can all degrade the data of interest. Furthermore, noise can be introduced by transmission errors and compression (Gursharan Kaur *et al.*, 2016). Figure 2.6 shows the key stages in digital image processing.

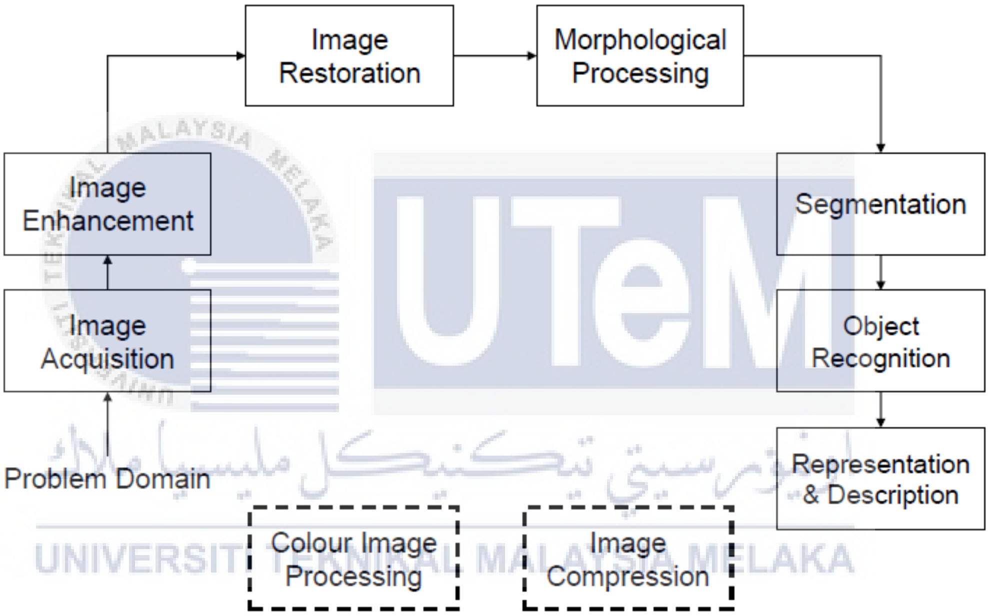

Figure 2.6: Key Stages in Digital Image Processing

Besides that, from (Tourani & Shahbahrami, 2015) it has discussed that Video processing is a subcategory of Digital Signal Processing methods where the information and yield signals are video streams. In PCs, a standout amongst other approaches to achieve video examination objectives is utilizing picture handling techniques in every video outline. For this situation, movements are basically acknowledged by looking at successive edges. Video preparing incorporates pre-channels, which can cause differentiate changes and clamor end alongside video outlines pixel measure transformations. Featuring specific regions of recordings, erasing inadmissible lighting impacts, wiping out camera movements and evacuating edge antiquities are performable utilizing video handling strategies.

(Panda, Naik, & Patel, 2015) explained that a picture of the road can be represented as a digital image, which is actually binary data. This picture is utilized as essential info. However, a picture, when it is caught from the indigenous habitat, is crude and unformatted. The field of advanced picture preparing contains techniques including handling computerized pictures by methods for a PC. An advanced picture is made out of a limited number of components, each of which has a specific area and esteem. These components are called picture components or pixels. Picture preparing rotates around issues identified with picture portrayal, their pressure, and different other complex operations, which can be completed on the picture information. The operations that go under picture preparing are picture upgrade operations, for example, honing, obscuring, lighting up and edge improvement.

2.6 Traffic Light Controller

Traffic light controller is sensors canvassed in the road to find the inhabitance of activity holding up at the light. Thusly, it can reduce the time when a green flag is given to a clear road. A clock is as frequently as conceivable used as a default in the midst of times of low activity thickness and as a fortification, if the sensors fall flat. The normal limit of activity lights requires more than slight control and coordination to ensure that activity moves as effectively and safely as could be normal considering the present situation and that individuals by walking are guaranteed secured when they cross the road. A variety of different control frameworks are used to complete this, going from basic perfect timing instruments to complex electronic control and coordination frameworks that self-fit in with restrain concede to people using the road. Figure 2.7 below shows a generic traffic light concept.

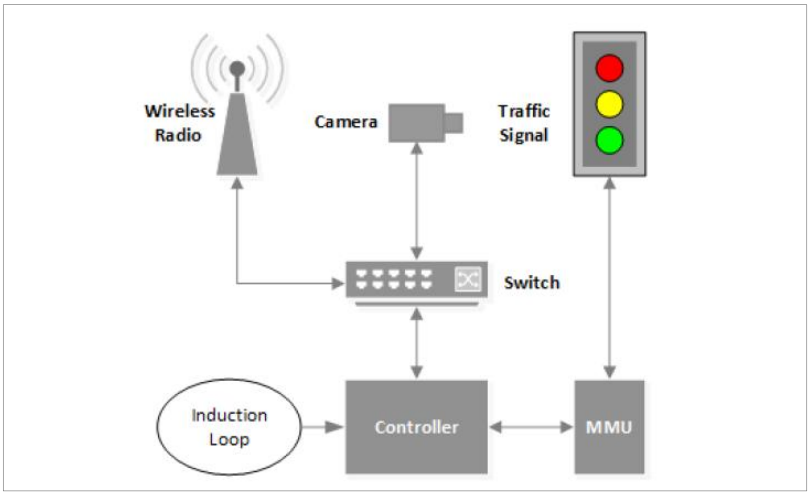

Figure 2.7: A generic traffic light concept (Vinh Thong Ta, 2016)

(Vinh Thong Ta, 2016) stated that sensors are fundamentally used to recognize vehicles and measure vehicle-related data, for instance, speed. Enlistment circles are utilized (by a few frameworks, for example, SCATS and SCOOT) to distinguish and check vehicles passing certain purposes of the street. Circle locators are set underneath the road, measuring an alteration in inductance as a result of the metal body of the vehicle. Camcorders are additionally comprehensively introduced to distinguish vehicles and measure their speed. Activity controllers (Base stations) are associated with the sensors and make estimation and streamlining on the sensor contributions, and also control light states. Controllers are normally set in a metal bureau (that gives some level of physical security) by the roadside and enact the movement lights in light of transfers.

Moreover, the movement light idea raises a model for exchange in the matter of how advertise members and system administrators can interface with each other in future. Utilizing the rationale of a movement light, between the green market stage, in which the power matrix capacities for the commercial center without confinements and the red stage in which the framework steadiness is imperiled, a golden middle stage is likewise characterized. The golden stage is entered if a potential system bottleneck exists in a characterized arrange portion. In the golden stage, dispersion framework administrators call upon the adaptability offered by advertise members in that system section so as to keep a red stage circumstance. The Keen Network Activity Light Idea portrays the way toward deciding adaptability and calling upon adaptability utilizing contextual investigations for each of the three movement light stages (Berlin, 2015).

2.6.1 Image Processing in Traffic Light Control

Image processing is a superior strategy to control the state change of the traffic light. It demonstrates that it can diminish the traffic blockage and keeps away from the time being squandered by a green light on a vacant street. It is additionally more dependable in assessing vehicle nearness since it utilizes real traffic images. In the research paper written by (Ajmal & Hussain, 2010) said that an underlying stride for activity controlling is vehicle identification and order utilizing movement measuring systems. Picture preparing based procedures are a standout amongst the most generally utilized systems which accomplish this goal. Numerous calculations have been proposed associated with vehicle identification and arrangement. Picture division and edge recognition strategies are utilized. Arrangement of vehicles in view of their sizes or shapes assumes an importation part in movement administration and stream control. Independent of the calculation or procedure being utilized, camera situating and the nature of camera play a vital and basic part in vehicle recognition. High elevation flying camera is a case of camera situating which is frequently utilized because of its wide zone scope.

Previous studies have revealed that one way to improve traffic flow and safety of the current transportation system is to apply automation and intelligent control methods (Prashant Jadhav *et al.*, 2016). As the number of road users constantly increases, and resources provided by current infrastructures are limited, intelligent control of traffic will become a very important issue in the future. Traffic congestion may result due to heavy traffic at a junction. To avoid congestion there are so many traffic management techniques available. But no technique is perfect by itself as the real time situations are generally continuously changing and the system has to adapt itself to change in the continuously changing circumstances.

Moreover, another research that was carried out by Parichita Basak and Ramandeep Kaur (Parichita Basak & Ramandeep Kaur, 2015) also discussed on the detection and classification of vehicle. They stated that detection and classification is important for effective traffic control which traffic related information needs to be collected and analyzed. There are also some other method which are Magnetic Wireless Sensor detectors, Radio Frequency, Regression Analysis, Motion Vector Technique and others. Standard traffic control system nowadays is manually control, in which more man-power is required. Manually it is not likely to control traffic efficiently. Another system is automatic controlling, which uses timer for each phase. This automatic controlling uses electronic sensors to detect vehicles and produce signals. For this case, the time may get wasted by a green light on empty road. All these disadvantages are supposed to be removed via image processing, in which detection of vehicles is done through pictures in place of installed sensors.

Moreover, todays with wide advancement of discrete getting information, for example, scanners and computerized cameras, picture handling has been truly functional. Pictures from accepting data from scanners and cameras, has dependably been seen as a huge clamor or obscure and now and again has an issue of obscuring the limits of the examples in picture that causes determination lessening of the got picture. Utilizing picture preparing is compelling for expelling these obstructions. One of its capacities is about movement control (Najjar A. & Ghaffary H., 2015).

There are heaps of strategies proposed to outline a keen movement framework, for instance, fluffy based controller and morphological edge recognition strategy are proposed in. This procedure depends on the estimation of the activity thickness by relating the live movement picture with a reference picture. The higher the distinction is, higher activity thickness is recognized. Programmed movement observing and reconnaissance are vital for street use and administration. Movement parameter estimation has been a dynamic research region for the improvement of wise Transportation frameworks (ITS). For ITS applications activity data should be gathered and disseminated. Different sensors have been utilized to evaluate movement parameters for refreshing activity data (Ankita Panda *et al*., 2015).

Other than that, current movement control strategies including attractive circle finders covered in the street, infra-red and radar sensors as an afterthought give constrained activity data and require isolate frameworks for movement tallying and for activity observation. Inductive circle locators do give a savvy arrangement, be that as it may they are liable to a high disappointment rate when introduced in poor street surfaces, diminish asphalt life and discourage movement amid support and repair. Infrared sensors are influenced to a more prominent degree by mist than camcorders and can't be utilized for successful observation. Interestingly, video-based frameworks offer many focal points contrasted with conventional procedures. They give more activity data, join both observation and movement control advances, are effectively introduced, and are adaptable with advance in picture handling strategies (Vikramaditya Dangi *et al.*, 2012)

(Vismay Pandit *et al.*, 2014) also stated that different sensors have been utilized to appraise activity parameters for refreshing movement data. Attractive circle locators have been the most utilized advancements, yet their establishment and support are badly arranged and may wind up plainly contrary with future ITS framework. It is very much perceived that vision-based camera framework are more adaptable for activity parameter estimation. Notwithstanding subjective portrayal of street blockage, picture estimation can give quantitative depiction of movement status including speeds, vehicle checks, and so on. Additionally, quantitative movement parameters can give us finish activity stream data, which satisfies the prerequisite of movement administration hypothesis. Picture following of moving vehicles can give us quantitative portrayal of activity stream.

2.7 Analysis

Problem analysis can be described as a set of techniques that defines the unsatisfied of end user areas with existing solutions meanwhile requirement analysis is done in order to understand the problem for which the project system is to solve. This analysis begins by presenting the problem analysis.

2.7.1 Problem Analysis

In order to output a well classified video for vehicle detection and counting, the quality of input video data is important. A digital camera was used for processing. The computerized camera got must be considered before utilizing. The video outline should be prepared in few stages keeping in mind the end goal to fulfill the picture prerequisite. The video required for this investigation is vehicle locale. The non-vehicle locale must be covered before utilizing it for identification and tallying. Over that, obtaining of an appropriate report territory is likewise essential in this examination. Malacca Focal district was picked in light of the fact that it is one of the states that is have a swarmed and occupied road. By using this study area, the output of the study could be more informative for the end user.

2.7.2 Data Requirement

Digital camera technology was used in this project. The video will be captured by using digital camera technology to collect the data.

2.7.3 Software Requirement

There are mainly one software being used in this study as shown in Table 2.3.

Table 2.3: Software and Hardware requirement

Requirement	Use
MATLAB R2017a	Used for image processing and video processing
Digital Camera Technology	Used for capture video

2.8 Conclusion

As a conclusion, this chapter discusses on the background studies of image processing, video processing, drones remote sensing and image processing in traffic light control. This data is critical for advance examination and conduction of the investigation. This part additionally cover on the investigation necessities of the task. The next chapter will be on the methodology and design.

CHAPTER III

METHODOLOGY AND DESIGN

3.1 Introduction

This chapter discusses the methodology involved in this project ranging from data collection, data analysis, experimental development, and result. A detail discussion regarding the techniques used in achieving the objectives of this project is given. This chapter introduces the design for the output in carrying out detection and counting using the digital camera. In order to study the designing process, there is much methodological decision needed. That is because it may bring a lot effect directly toward to the overall quality of this project and the accuracy result. After collecting the data video from the digital camera, it will undergo several processes to generate out the output final result. For each stage of the process is important because it will influence the final result answer. So, in the next session, it will be mentioned it.

3.2 Phases

In order to achieve the objectives, the four phases involved are **Phase One** – simulating of traffic light using digital camera technology data, **Phase Two** – design and develop Procedure/Algorithm to classify vehicle detection and counting, **Phase Three** – experimental results, **Phase Four** – evaluating and testing procedure/algorithm to classify vehicle detection and counting and **Phase Five** – conclusion.

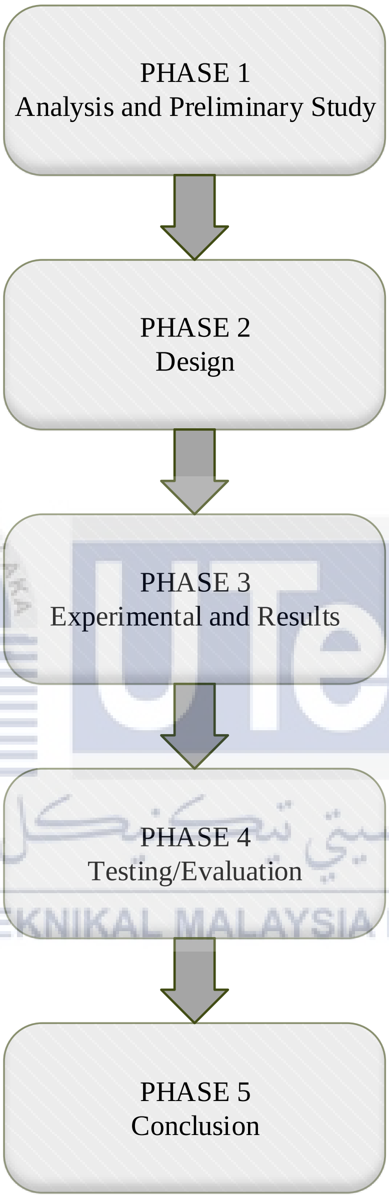

Figure 3.1: Phases of Experiment

3.2.1 Phase One – Analysis and Preliminary Study

Gathering the information regarding the need and importance of digital camera in detection and counting of vehicle. This phase study on the problem faced by the current traffic management in determining the vehicle detection and also counting. On top of that, this phase do analysis on Unmanned Aerial Vehicle (UAV) or Drones Remote Sensing technique and type of data used in previous vehicle detection and counting methods. By learning the methods, the study will develop a procedure to do detection and counting of vehicle. Comparisons of various methods will be studied in literature studies. Data to be used collected from the Digital Camera Technology. During this phase, I did traffic light survey by visiting of the estate, Malacca mapped in Figure 1.2. During that visit, I interviewed the villager and recorded some important information.

3.2.2 Phase Two – Design

This is the most vital part in this examination. The procedure included are picking input, concealing of picture and do correlation in light of proposed strategy. The exhibitions of the system/technique will be assessed by methods for visual understanding and exactness appraisal.

3.2.3 Phase Three – Experimental and Results

In this stage, the pre-handled video from the computerized camera will be prepared. It will be prepared utilizing the proposed strategy/method. Output video will be shown. The greater part of the assignments will make utilization of top of the line programming, for example, MATLAB (image processing). Towards the later phases of this, yield delivered by various process in configuration stages is incorporated to create last outcomes.

3.2.4 Phase Four – Testing/Evaluation

The results are evaluated and tested in this phase. The result will be evaluated based on the objective of the project by testing the methods implemented in the project. The results will be evaluate in term of accuracy by comparing the methods used in the experiments. The result of the testing will be recorded in the project.

3.2.5 Phase Five – Conclusion

Make a conclusion from the comparisons. The conclusion will be make based on the results recorded in the previous phase. This includes the techniques or methods that are most suitable for this project besides revealing the findings of the project.

3.3 Project Schedule and Milestone

The Table 3.1 below shows the schedule and milestone all the way through completing this project.

Table 3.1: Final Year Project Schedule and Milestone

Date Completed	Milestone	Project Activites
13 – 17 Feb	Preparation of proposal	Proposal Submission
20 – 24 Feb	Correction/Improvement of proposal	Proposal Correction/Improvement
27 Feb – 3 Mar	Preparation of Chapter 1	Chapter 1: Introduction
6 – 10 Mar	Preparation of Chapter 1 and Chapter 2	Chapter 1 and Chapter 2
13 – 17 Mar	Preparation of Chapter 2	Chapter 2: Literature Review
20 – 24 Mar	Deliverable of Chapter 2, progress presentation 1 and preparation for Chapter 3	Chapter 2 and Chapter 3: Methodology and Design
27 – 31 Mar	Demo, preparation of Chapter 3 and Chapter 4	Demo, Chapter 2 and Chapter 3

3 – 7 Apr	**MID SEMESTER BREAK**	
10 – 14 Apr	Demo, deliverable of Chapter 3 and preparation for Chapter 4	Demo and Chapter 4: Implementation and Results
17 – 21 Apr	Demo, progress presentation 2 and preparation for Chapter 4	Demo and Chapter 4
24 – 28 Apr	Project Demo	
1 – 5 May and 8 – 12 May	Final Year Project 1 report Demo	Demo
15 – 19 May	Demo, deliverable of complete Final Year Project 1 draft report	Complete Final Year Project 1 Draft Report
22 – 26 May	Presentation	Final Presentation of Final Year Project 1
29 May – 2 Jun	Correction on the draft report based on the comments by the Supervisor and Evaluator during the final presentation session and deliverable of complete Final Year Project 1 Logbooks	Complete Final Year Project 1 Logbooks
3 July	Preparation of Chapter 5	Chapter 5: Accuracy Assessment
17 July	Preparation and deliverable of Chapter 6	Chapter 6: Conclusion
31 July	Drafting full report	Draft full report
7 August	Deliverable of Full Report	Full Report
14 August	Presentation and report correction	Final Presentation and report correction

3.4 Design on Vehicle Detection and Counting

This part will demonstrate the procedure or the method to be done so as to characterize the discovery and tallying of vehicle. There are a few procedures to experience by the information video before delivering yield video. Each procedure produces yield to the following period of picture handling. Each eliminate of preparing gives distinctive outcomes that can improve the past video and shape a superior video for conclusive handling.

Figure 3.2 shows the step stages to classify detection and counting of vehicle from an input of a video from digital camera. Each step will be explained in detail. Each step is important to produce a good video output.

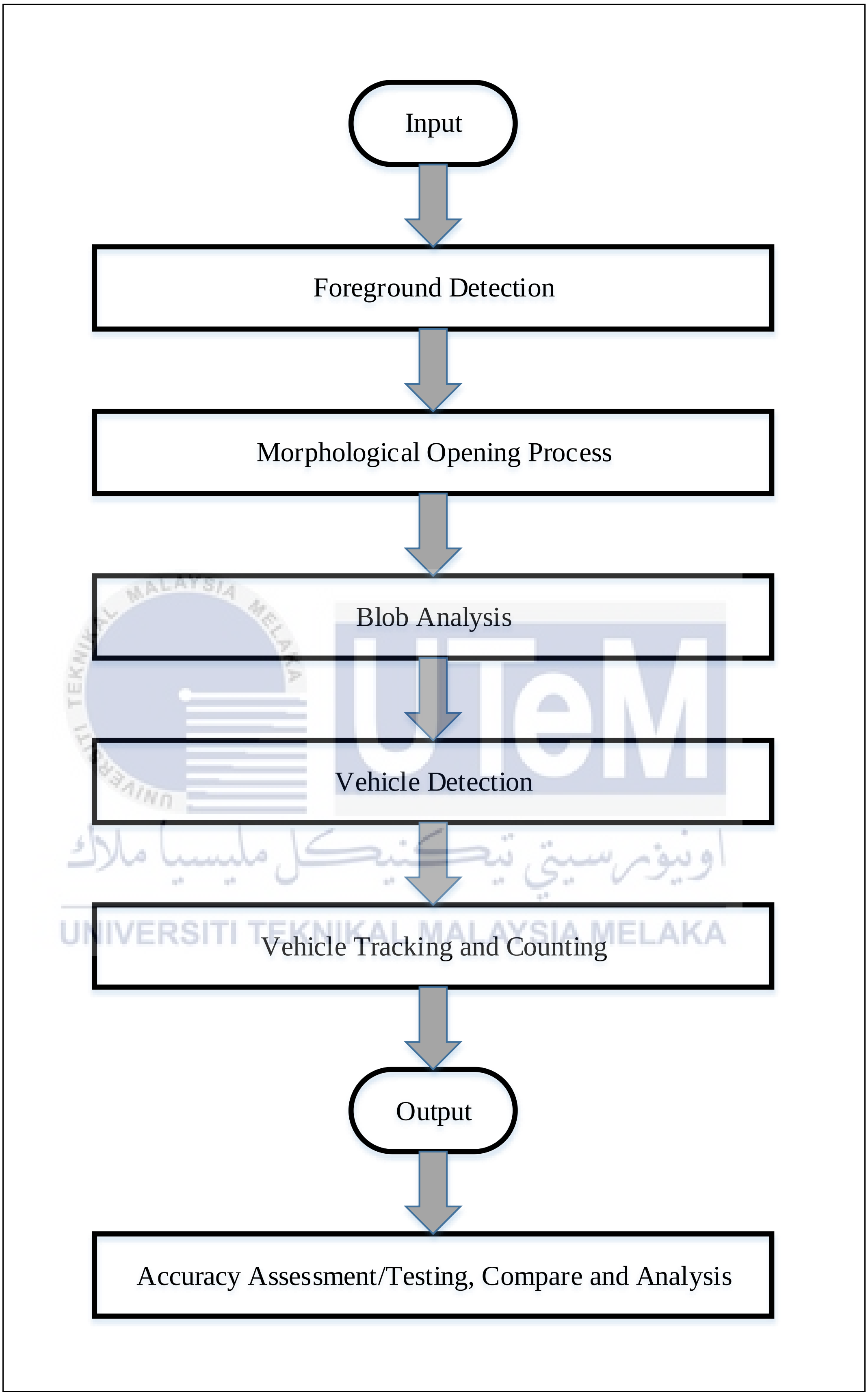

Figure 3.2: Vehicle Detection and Counting Process

3.4.1 Input

The input of the project will be the video from the digital camera. The cover area of the data is Malacca Central, Malaysia covering on the traffic light area. The provided video are used in the subsequent experiments.

3.4.2 Foreground Detection

In the first part, a background model is determined and in the second part, by comparing that background model to the current frame, the foreground objects are detected. Here, I have used foreground detector system object found in MATLAB that uses color or grayscale video frame and compare with a background model to determine whether individual pixels are part of the background or the foreground. Gaussian Mixture Models (GMM) concept has been used in Foreground Detector for clustering the points in video frame for background modelling. Background Subtraction Flow Diagram is as in Figure 3.3.

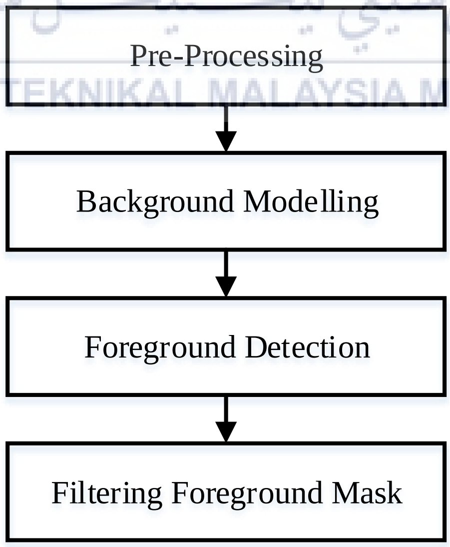

Figure 3.3: Background Subtraction Flow Diagram

3.4.3 Morphological Opening Process

In this process, the video frame is processed using morphological opening process. The opening serves in computer vision and image processing as a basic workhorse of morphological noise removal. Opening removes small objects from the foreground (usually taken as the bright pixels) of an image, placing them in the background.

3.4.4 Blob Analysis

Blob analysis recognizes potential questions and puts a box around them. It finds the region of the blob and from the rectangular fit around each blob, the centroid of the question can be separated for following the protest. An extra decide that the proportion of zone of blob to the territory of rectangle around a blob ought to be more noteworthy than 0.4 guarantees that superfluous articles are not identified.

3.4.5 Vehicle Detection

The videos taken were processed for vehicle detection through an MATLAB algorithm. Here, I have used Blob Analysis technique that is available in MATLAB for using the filtered image frame for the detection of vehicles. Blob detection refers to mathematical methods that are aimed at detecting regions in a digital image that differ in properties, such as brightness or color, compared to areas surrounding those regions.

3.4.6 Vehicle Tracking and Counting

Tracking is done just inside a particular area of the frame, called Count Box, to guarantee superfluous excess in calculation and higher execution. The black box is the tally box locale. Tracking is finished via hunting down centroids in a little rectangular district around centroids recognized in the before outline, if not discovered then it is added to an exhibit as a recently discovered protest.

3.4.7 Output

The output is the results of the whole process of vehicle detection and counting. End user can use the output of the process to obtain information such as manage the traffic light congestion. The video from the digital camera is the main output of this project.

3.4.8 Accuracy Assessment/Testing, Compare and Analysis

Different type of situation was tested in this project. The accuracy of the detection and counting was recorded. The analysis was done to verify the reliance of the results in this project.

3.5 Conclusion

As a conclusion, this part examines about the procedure engaged with the undertaking and the philosophy utilized. The entire stream and the capacity of the strategy have been clarified. Each procedure or methodology is given a general clarification. Additionally handling will be done in the following, result part.

CHAPTER IV

IMPLEMENTATION AND RESULTS

4.1 Introduction

This section portray the procedures of the examination in more point by point way. In this stage, the procedure will be performed methodically and deliberately. This is an imperative stage as the last outcomes relying upon the precision of the each ensuing procedures. In this procedure, the particular strategies and procedures are exceptionally fundamental.

4.2 Video Pre-Processing

The video from the digital camera is pre-processed before being used for the image processing purpose. It is also ensures that the video can give a good result to achieve the objectives. There are few processes that will be done on that video frame such as input video, foreground detection, morphological opening process, blob analysis, vehicle detection, and vehicle tracking and counting.

4.3 Input Video

The input video of this venture is caught from a digital camera. This video was taken at the Malacca Central. The camera was utilized to catch the video from the upper perspective of the movement at Malacca Central. The video that will be utilized as shown in Figure 4.1, Figure 4.2 and Figure 4.3. The video were taken in various condition which are less vehicle and heaps of vehicle.

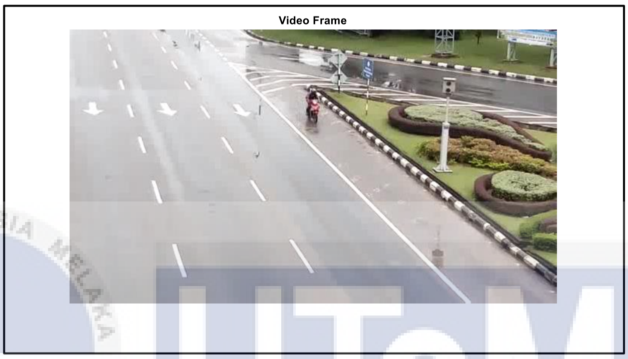

Figure 4.1: Morning category

Figure 4.2: Midday category

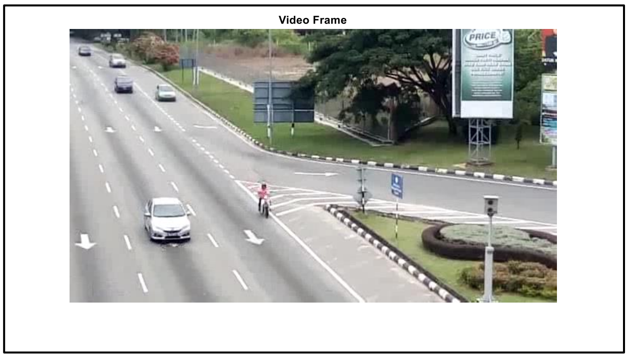

Figure 4.3: Evening category

4.4 Foreground Detection

As opposed to promptly handling the whole video, it will begin by getting an underlying video frame in which the moving articles are segmented from the background. The foreground detector requires a specific number of video frames keeping in mind the end goal to instate the Gaussian mixture model. For this part, it will utilize initial a few frames to instate three Gaussian modes in the mixture model. After the procedure, the indicator starts to yield more reliable segmentation results. The three figure below (Figure 4.4, Figure 4.5 and Figure 4.6) show the foreground mask computed by the detector.

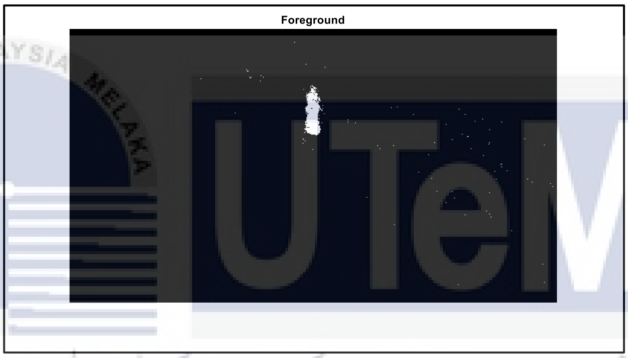

Figure 4.4: Foreground detection in Morning category

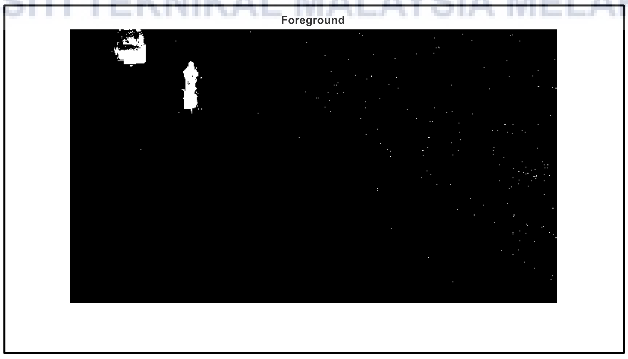

Figure 4.5: Foreground detection in Midday category

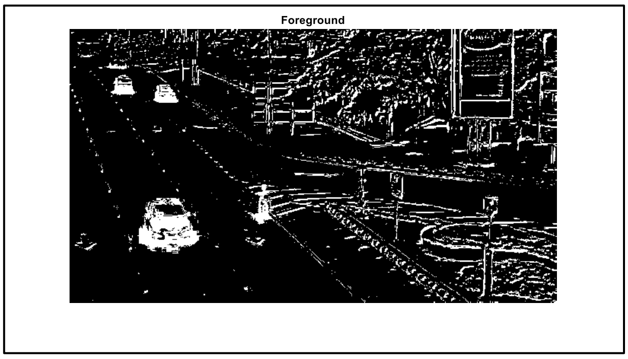

Figure 4.6: Foreground detection in Evening category

4.5 Morphological Opening Process

The foreground segmentation process is not perfect and often includes undesirable noise. Therefore, the video frame then undergo morphological opening to remove the noise and to fill gaps in the detected objects. Figure 4.7, Figure 4.8 and Figure 4.9 below shows the clean foreground after the morphological opening process.

Figure 4.7: Clean Foreground after Morphological Opening Process in Morning

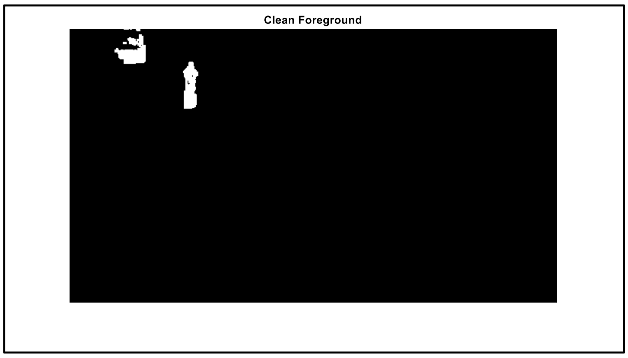

Figure 4.8: Clean Foreground after Morphological Opening Process in Midday

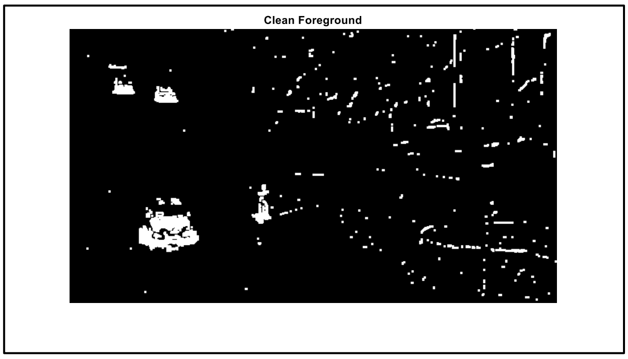

Figure 4.9: Clean Foreground after Morphological Opening Process in Evening

4.6 Blob Analysis

After Blob Analysis of the filtered image, the vehicle is detected and bounded by box as shown in figure below for each category.

Figure 4.10: Detected Vehicles after Blob Analysis in Morning

Figure 4.11: Detected Vehicles after Blob Analysis in Midday

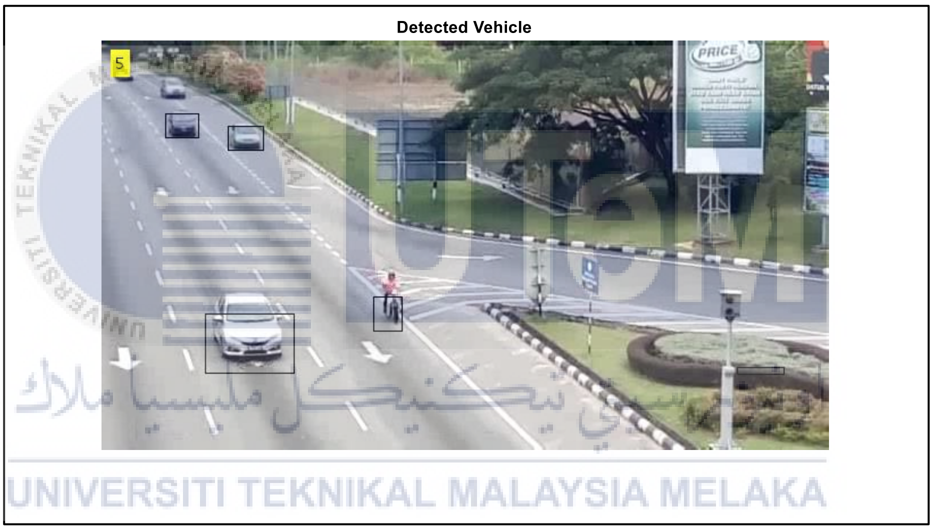

Figure 4.12: Detected Vehicles after Blob Analysis in Evening

4.7 Vehicle Detection

Blob Analysis was used for the detection of vehicles. Blob detection refers to mathematical methods that are aimed to detecting regions in a digital image. In order to achieve, vehicle detection and counting this proposed method tracks each blob within successive image frames returning output parameters like area, centroid and bounding box.

4.8 Vehicle Tracking and Counting

Tracking is completed just inside a particular district of the frame, called Count Box, to guarantee pointless repetition in calculation and higher execution. The black box is the tally box locale. Following is finished via hunting down centroids in a little rectangular district around centroids recognized in the before outline, if not discovered then it is added to an exhibit as a newly found object.

4.9 Output

The output video shows the bounding boxes around the autos. The quantity of bounding boxes corresponds to the quantity of autos found in the video frame. It show the quantity of discovered autos in the upper left corner of the processed video frame. Figure 4.13, Figure 4.14 and Figure 4.15 show the vehicle detection and counting.

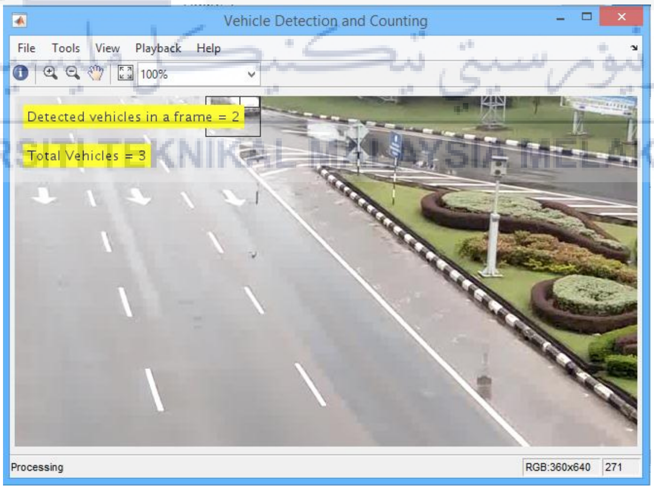

Figure 4.13: Output for Vehicle Detection and Counting in Morning

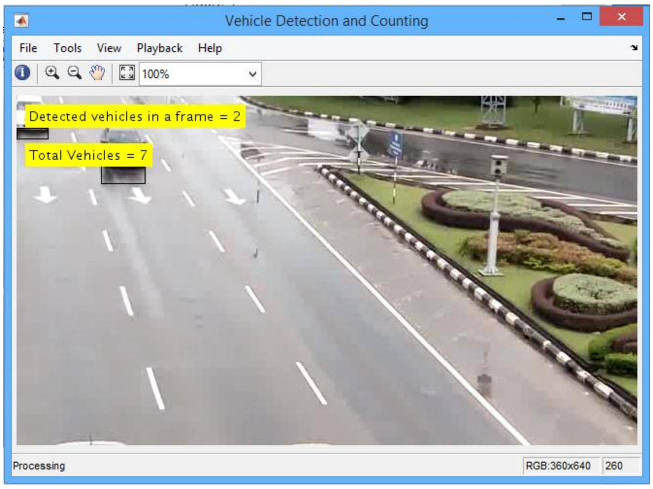

Figure 4.14: Output for Vehicle Detection and Counting in Midday

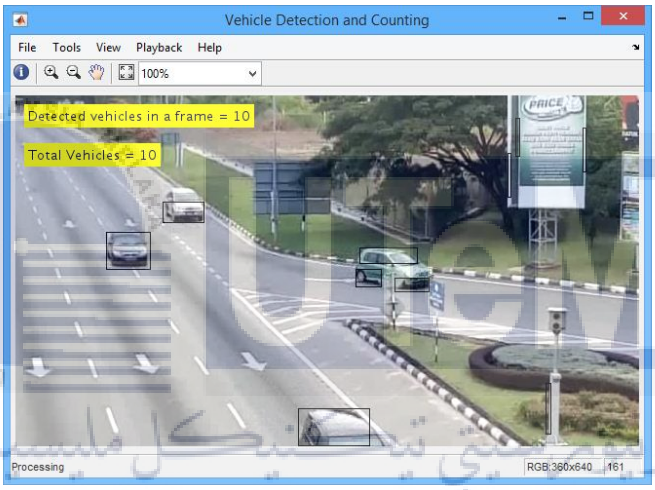

Figure 4.15: Output for Vehicle Detection and Counting in Evening

4.10 Accuracy Assessment/ Testing, Compare and Analysis

To recognize the huge of this venture, examination on accuracy assessment is going about as essential part to decide the yield of the outcome whether is precise and trustable. In this manner, at the below have attracted out a table to express all the output result for each class.

For the accuracy assessment, I computed the accuracy percentage and error percentage.

The error percentage can be expressed as:

$$Error\ percentage = \frac{|Predection\ amount\ of\ vehicle\ detected - Original\ amount\ of\ vehicle|}{Original\ amount\ of\ vehicle} \times 100\%$$

The accuracy percentage can be expressed as:

$$Accuracy\ percentage = (\ 100\% - Error\ rate\ percentage)$$

Table 4.1: Accuracy Assessment of Output

Category	**Classifier**	**Actual number of vehicle**	**Number of vehicle computed from digital camera**	**Accuracy percentage**	**Error percentage**
Morning	GMM	2	3	50%	50%
Midday	GMM	6	7	83.33%	16.67%
Evening	GMM	6	10	33.33%	66.67%

In light of the table above, it can be unmistakably observed that the early afternoon class (midday category) of video is given more exact outcome contrasted with morning and evening classification. The midday class has the most elevated exactness rate which is 83% above. In this way, through by midday classification it considered successful had done the detection process to get the correct aggregate sum of vehicle which is having less commotion in a video.

However, for the accuracy percentage and error rate percentage of morning category shows that their result also can be given the better and accurate result because it has an intangible difference compared to evening category that obviously show it result cannot even give the better and accurate result. From this result, it can be assume that difference time and atmosphere to capture the situation of traffic is hard to detect and get the right prediction result. The reason are because of the road surface, shadow, color of the vehicle and also the other thing that have the same intensity value with the brightness intensity of the vehicle and environment. Thus, those problem are disturbing the process of detection and influence the output result. In order to remove or avoid getting influence by other factor, there have further process to be carrying on in further research.

What's more, this classification sometimes give the exact outcome and some of the time not. In spite of the fact that its calculation did not give 100% exact but rather it can be utilized to detect and count the amount of vehicle out and about. That is implies this classifier is appropriate method to be done the classify video frame in this venture.

4.11 Conclusion

A basic and powerful framework which takes care of the issue under examination has been created. The recognition of vehicles in a blend movement circumstance of morning, midday and evening is correctly not surprisingly and the checking calculation is exact. The restriction of the created technique is that for each camera information encourage a lot of tuning of the parameters is required to accomplish the best execution. Likewise, it requires to some degree all the more handling time in very denced activity conditions.

CHAPTER V

ACCURACY ASSESSMENT / TESTING

5.1 Introduction

In this section, it will examines the precision evaluation of the venture result. This is a basic piece of this venture keeping in mind the end goal to check its practicability and usefulness. With a specific end goal to accomplish the goal of this venture, it will be direct on a few testing to guarantee the outcome is steady and solid to utilize. Accuracy assessment was done in three classification which are morning, midday and evening. All class can be ascertained utilizing forefront identifier and morphological filter for noise removal. In view of the test that have done, it was effective demonstrated that midday classification is the most best for this venture. This is on account of midday classification having the most minimal error rate and most noteworthy exactness rate. Along these lines, for the testing part it will take 3 unique specimens of video frame from the midday class to be exploratory.

5.2 Samples for Testing Experiment

Tests data for testing trial will include diverse standard to guarantee that distinctive basis or viewpoint won't be influence the outcome. These three examples of data will have diverse angle, for example, weather, separation of the vehicle from the advanced camera, the quantity of vehicle and kind of vehicle.

Figure 5.1: Sample 1

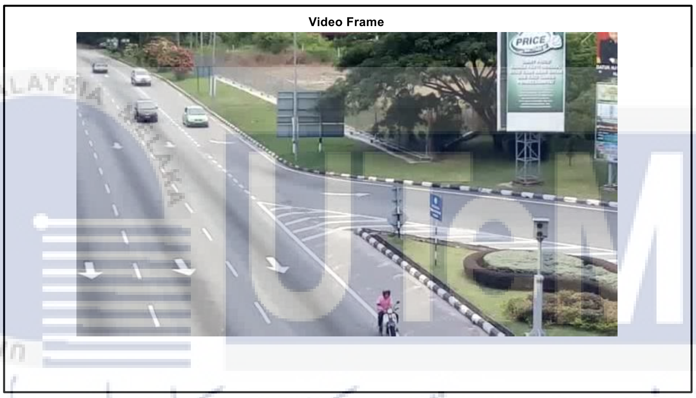

Figure 5.2: Sample 2

Figure 5.3: Sample 3

5.3 Comparison Analysis

In order to get the result, MATLAB software was used to compute the amount of vehicle in a video. Therefore, in this project I have use the above three samples data for the testing purpose. The testing procedure was same as suggested in the Chapter IV. However, the testing was being compute the amount of vehicle in a video will be according to the amount of black boxes around the detected vehicle. In order to test the technique and result getting from the Chapter IV is reliable and accurate, therefore in Chapter V the experiment will be following the procedure according it. Figure below shows the testing output result.

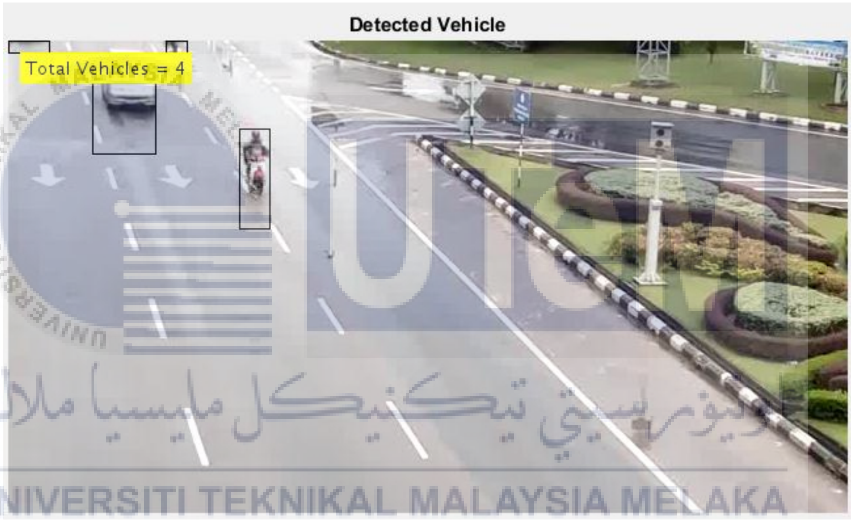

Figure 5.4: Output for Sample 1

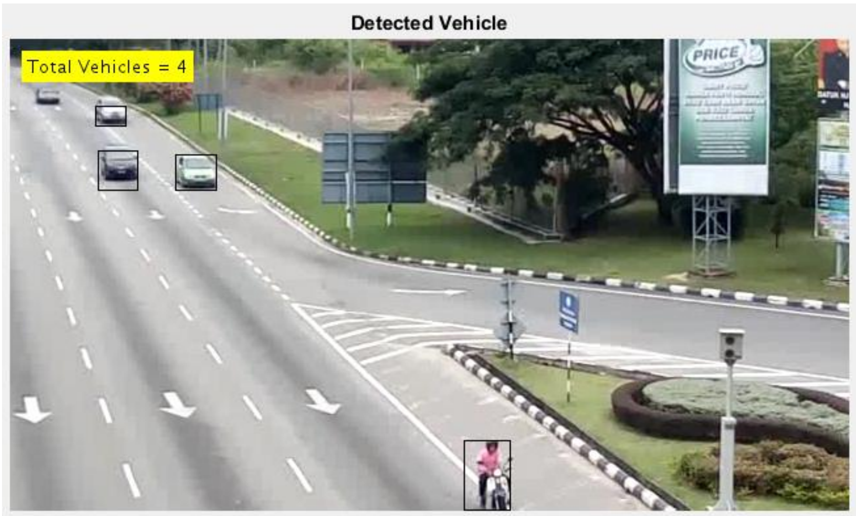

Figure 5.5: Output for Sample 2

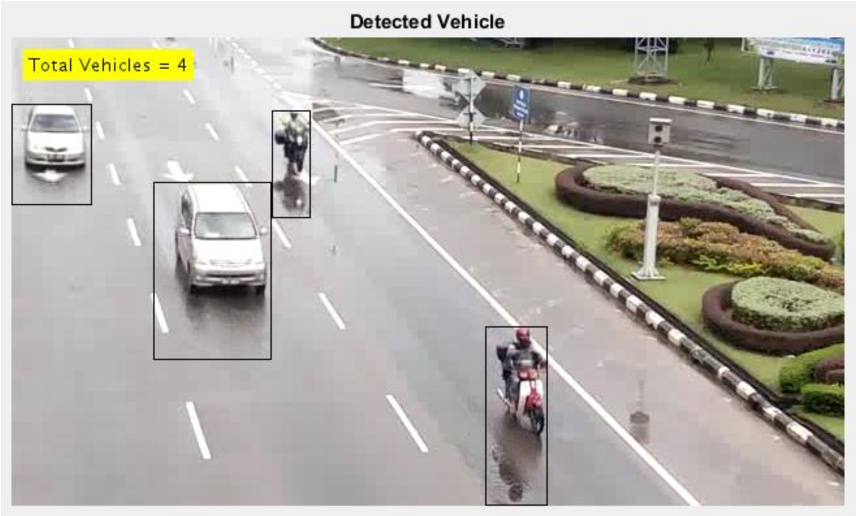

Figure 5.6: Output for Sample 3

In view of the yield given from the MATLAB program, the table underneath demonstrates the yield result, error percentage and accuracy percentage that was resolved in light of correlation between the genuine number of vehicles and number of vehicles processed from the advanced camera. The equation for the computation is the same as specify in the Chapter IV.

Table 5.1: Accuracy Assessment of 3 samples of data

No	Classifier	Category	Actual number of vehicle	Number of vehicle computed from digital camera	Accuracy percentage	Error percentage
1	GMM	Midday	3	4	66.67%	33.33%
2	GMM	Midday	5	4	80%	20%
3	GMM	Midday	4	4	100%	0

Based on the table above, sample 3 data having the highest accuracy which is 100%. From the sample 3 data, it can be clearly seen the difference between other two samples are the weather and distance of the vehicle from the digital camera. The distance of the vehicle from the digital camera for sample 2 is far compared to sample

1 and 3 which is nearer. Also for sample 1 and 3 it is rainy day. This indicates that the weather and the distance between the vehicles and camera influences the classification of vehicle. This is because when it is rainy, the shadow will be appeared and causes the detection becomes two for one object. The shadow will be having the similar intensity of colour with the object or other things that is darker. Thus, those things affecting the amount of vehicles detected.

Other than that, the part of moved of vehicle in a zone and the shade of vehicle additionally different reasons that influence the exactness rate. From the video that have been tried, it seen that more moved of vehicle in a territory and pack to each other won't be distinguished precisely. It makes the expanding of clamor that hard identify by the framework. At the point when the protest that should be distinguished are full with shadow and other pack vehicle, it will cause the commotion and furthermore expanding the error percentage and diminishing the exactness rate.

As per the examination from the Chapter IV, it just covers the less unique vehicle out and about. In any case, in the testing part it had prevailed to cover the diverse sort of vehicle out and about that went through in view of the circumstance. It has demonstrated that this venture is more adaptable toward the identification of any vehicle and not just restricted to auto as it was. Be that as it may, if the shade of protest is too splendid and have a similar shading with the forefront, it will impact the accuracy percentage.

5.4 Conclusion

An exactness evaluation methodology has been done in this part in light of the result of the venture. The midday class of video has demonstrated the best outcome. Despite the fact that there are many impacts, the exactness rate for the midday classification video gives the most elevated precision in registering the discovery and tallying the measure of the vehicle from the advanced camera video.

CHAPTER VI

CONCLUSION

6.1 Introduction

This final chapter will briefly describe the strengths and weakness of the result and the suggestion for improvement of the project in future.

6.2 Strengths

Alluding to Table 6.1, it demonstrates the diverse outcome in view of various class. The mistake commission for these three classifications which is morning, midday and evening is 50%, 16.67% and 66.67%. Thus, for these three classes, the midday classification has the most reduced mistake rate and most noteworthy exactness rate by contrasting the genuine number of vehicles and that processed from the computerized camera video. Since it has the most elevated precision, in the Chapter V has been concentrating on the testing of the midday class test. The test outcome demonstrated that it has 60% above for precision rate and under 40% blunder rate when tried on various video frame.

Table 6.1: Accuracy Assessment of Output

Category	Classifier	Actual number of vehicle	Number of vehicle computed from digital camera	Accuracy percentage	Error percentage
Morning	GMM	2	3	50%	50%
Midday	GMM	6	7	83.33%	16.67%
Evening	GMM	6	10	33.33%	66.67%

In the three investigations as appeared in the Table 6.2 beneath, the exactness rates were 66.67%, 80% and 100%. The test outcomes demonstrates somewhat unique precision because of the diverse sorts of situation that may impact the outcome. The situation is with respect to the distinctive climate, separation of the vehicle from the computerized camera, the quantity of vehicle and sort of vehicle. Despite the fact that these few viewpoint may impact the outcome yet regardless it gives the exactness at 60% or more.

Table 6.2: Accuracy Assessment of 3 samples of data

No	Classifier	Category	Actual number of vehicle	Number of vehicle computed from digital camera	Accuracy percentage	Error percentage
1	GMM	Midday	3	4	66.67%	33.33%
2	GMM	Midday	5	4	80%	20%
3	GMM	Midday	4	4	100%	0

6.3 Weakness

The limited number of training set causes the GMM to perform insufficiently. The cover range of intensity for vehicle class may also hamper the performance in detecting and counting the vehicles. The video frame are only used two different algorithms and it may causes the detection for more vehicles in a video frame to have more noise and eventually affect the result. Other than that, the shadow that appear especially when it is on rainy day may causes the vehicle detection cannot be accurate. The vehicle that have too bright or too dark colour also affecting the detection because of the same colour with the foreground. Therefore, the black box will not surrounding the vehicle and will not be counted. The angle of the camera is the most important for the detection because when the signboard was including in the video it may increasing the noise and affecting the detection and also affecting the result. Besides that, this project was found most suitable for midday category. If the detection is done from other type categories, the accuracy of the detection and counting will be less accurate.

6.4 Suggestion

For future change, the arranged video are smarter to be approved to amplify the cover scope of force. In this way discovery should be possible by any classes of vehicle shading. In addition, to get better execution, the calculation used to process the vehicle location is a vital viewpoint. More algorithm utilized is a decent approach to diminish the commotion which are non-important to the venture. By decreasing the commotion of the video, more exact outcomes might be gotten. It should assess the vehicle shading for better discovery of autos. Besides, future examinations additionally ought to accentuate on robotized identification to make the location all the more easily and accommodation.

6.5 Conclusion

Taking everything into account, the midday class is found to have the most astounding precision and low mistake contrasted with morning and evening classifications in identifying and tallying the vehicles. The entire outline of the analysis is significant to be utilized as a part of vehicle detection. The encompassing condition, weather or atmosphere category, and commotion inside the video are to be the primary variables affecting the outcome.

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ATTACHMENTS

A1 – Coding

```
%% Vehicle Detection and Counting Using Gaussian Mixture Models
% Condition: MORNING

close all;
clear all;
clc;

% Import video and initialize foreground detector
foregroundDetector = vision.ForegroundDetector('NumGaussians', 3,
...
    'NumTrainingFrames', 100);

videoReader = vision.VideoFileReader('testpagi.avi');
for i = 1:30
    frame = step(videoReader); % read the next video frame
    foreground = step(foregroundDetector, frame);
end

% Detect vehicles in an initial video frame
se = strel('square', 3);
filteredForeground = imopen(foreground, se);

% find bounding boxes of each connected component corresponding to
% a moving vehicle
blobAnalysis = vision.BlobAnalysis('BoundingBoxOutputPort', true,
...
    'AreaOutputPort', false, 'CentroidOutputPort', false, ...
    'MinimumBlobArea', 150);
bbox = step(blobAnalysis, filteredForeground);

% draw green boxes around detected vehicle
result = insertShape(frame, 'Rectangle', bbox, 'Color', 'black');

% display the number of found vehicle in the video frame
numVehicles = size(bbox, 1);
result = insertText(result, [10 10], numVehicles, 'BoxOpacity', 1,
...
    'FontSize', 14);

% Process the remaining video frames
```

```
videoPlayer = vision.VideoPlayer('Name', 'Vehicle Detection and
Counting');
videoPlayer.Position(3:4) = [650,400];  % window size: [width,
height]
se = strel('square', 3); % morphological filter for noise removal

%subplot(2,2,1); imshow(frame); title('Video Frame');
%subplot(2,2,2); imshow(foreground); title('Foreground');
%subplot(2,2,3); imshow(filteredForeground); title('Clean
Foreground');
%subplot(2,2,4); imshow(result); title('Detected Vehicle');

figure; imshow(frame); title('Video Frame');
figure; imshow(foreground); title('Foreground');
figure; imshow(filteredForeground); title('Clean Foreground');
figure; imshow(result); title('Detected Vehicle');

%x = 0;
while ~isDone(videoReader)

    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
    bbox = step(blobAnalysis, filteredForeground);

    % Draw bounding boxes around the detected vehicles
    result = insertShape(frame, 'Rectangle', bbox, 'Color',
'black');

    % Display the number of vehicles found in the video frame
    numVehicles = size(bbox, 1);
    result2 = insertText(result, [10 10], ['Detected vehicles in a
frame = ', num2str(numVehicles)], 'BoxOpacity', 1, ...
        'FontSize', 14);

    step(videoPlayer, result2);  % display the results
end

% Display the total number of vehicles found in the video
total_vehicle = (numel(bbox)) - 5;
result3 = insertText(result2, [10 50], ['Total Vehicles = ',
num2str(total_vehicle)], 'BoxOpacity', 1, ...
        'FontSize', 14);

step(videoPlayer, result3);  % display the results

release(videoReader); % close the video file
```

```
%% Vehicle Detection and Counting Using Gaussian Mixture Models
% Condition: MIDDAY

close all;
clear all;
clc;

% Import video and initialize foreground detector
foregroundDetector = vision.ForegroundDetector('NumGaussians', 3,
...
    'NumTrainingFrames', 200);

videoReader = vision.VideoFileReader('testtengahari.avi');
for i = 1:50
    frame = step(videoReader); % read the next video frame
    foreground = step(foregroundDetector, frame);
end

% Detect vehicles in an initial video frame
se = strel('square', 3);
filteredForeground = imopen(foreground, se);

% find bounding boxes of each connected component corresponding to
% a moving vehicle
blobAnalysis = vision.BlobAnalysis('BoundingBoxOutputPort', true,
...
    'AreaOutputPort', false, 'CentroidOutputPort', false, ...
    'MinimumBlobArea', 150);
bbox = step(blobAnalysis, filteredForeground);

% draw green boxes around detected vehicle
result = insertShape(frame, 'Rectangle', bbox, 'Color', 'black');

% display the number of found vehicle in the video frame
numVehicles = size(bbox, 1);
result = insertText(result, [10 10], numVehicles, 'BoxOpacity', 1,
...
    'FontSize', 14);

% Process the remaining video frames
videoPlayer = vision.VideoPlayer('Name', 'Vehicle Detection and
Counting');
videoPlayer.Position(3:4) = [650,400];  % window size: [width,
height]
se = strel('square', 3); % morphological filter for noise removal

%subplot(2,2,1); imshow(frame); title('Video Frame');
%subplot(2,2,2); imshow(foreground); title('Foreground');
%subplot(2,2,3); imshow(filteredForeground); title('Clean
Foreground');
%subplot(2,2,4); imshow(result); title('Detected Vehicle');

figure; imshow(frame); title('Video Frame');
figure; imshow(foreground); title('Foreground');
figure; imshow(filteredForeground); title('Clean Foreground');
figure; imshow(result); title('Detected Vehicle');
```

```
x = 0;
while ~isDone(videoReader)

    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
    bbox = step(blobAnalysis, filteredForeground);

    % Draw bounding boxes around the detected vehicles
    result = insertShape(frame, 'Rectangle', bbox, 'Color',
'black');

    % Display the number of vehicles found in the video frame
    numVehicles = size(bbox, 1);
    result2 = insertText(result, [10 10], ['Detected vehicles in a
frame = ', num2str(numVehicles)], 'BoxOpacity', 1, ...
        'FontSize', 14);

    step(videoPlayer, result2);  % display the results
end

% Display the total number of vehicles found in the video
total_vehicle = (numel(bbox)) - 1;
result3 = insertText(result2, [10 50], ['Total Vehicles = ',
num2str(total_vehicle)], 'BoxOpacity', 1, ...
        'FontSize', 14);

step(videoPlayer, result3);  % display the results

release(videoReader); % close the video file
```

```
%% Vehicle Detection and Counting Using Gaussian Mixture Models
% Condition: EVENING

close all;
clear all;
clc;

% Import video and initialize foreground detector
foregroundDetector = vision.ForegroundDetector('NumGaussians', 3,
...
    'NumTrainingFrames', 30);

videoReader = vision.VideoFileReader('testpetang.avi');
for i = 1:140
    frame = step(videoReader); % read the next video frame
```

```
    foreground = step(foregroundDetector, frame);
end

% Detect vehicles in an initial video frame
se = strel('square', 3);
filteredForeground = imopen(foreground, se);

% find bounding boxes of each connected component corresponding to
% a moving vehicle
blobAnalysis = vision.BlobAnalysis('BoundingBoxOutputPort', true,
...
    'AreaOutputPort', false, 'CentroidOutputPort', false, ...
    'MinimumBlobArea', 150);
bbox = step(blobAnalysis, filteredForeground);

% draw green boxes around detected vehicle
result = insertShape(frame, 'Rectangle', bbox, 'Color', 'black');

% display the number of found vehicle in the video frame
numVehicles = size(bbox, 1);
result = insertText(result, [10 10], numVehicles, 'BoxOpacity', 1,
...
    'FontSize', 14);

% Process the remaining video frames
videoPlayer = vision.VideoPlayer('Name', 'Vehicle Detection and
Counting');
videoPlayer.Position(3:4) = [650,400];  % window size: [width,
height]
se = strel('square', 3); % morphological filter for noise removal

%subplot(2,2,1); imshow(frame); title('Video Frame');
%subplot(2,2,2); imshow(foreground); title('Foreground');
%subplot(2,2,3); imshow(filteredForeground); title('Clean
Foreground');
%subplot(2,2,4); imshow(result); title('Detected Vehicle');

figure; imshow(frame); title('Video Frame');
figure; imshow(foreground); title('Foreground');
figure; imshow(filteredForeground); title('Clean Foreground');
figure; imshow(result); title('Detected Vehicle');

x = 0;
while ~isDone(videoReader)

    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
    bbox = step(blobAnalysis, filteredForeground);

    % Draw bounding boxes around the detected vehicles
```

```
    result = insertShape(frame, 'Rectangle', bbox, 'Color',
'black');

    % Display the number of vehicles found in the video frame
    numVehicles = size(bbox, 1);
    result2 = insertText(result, [10 10], ['Detected vehicles in a
frame = ', num2str(numVehicles)], 'BoxOpacity', 1, ...
        'FontSize', 14);

    step(videoPlayer, result2);  % display the results
end

% Display the total number of vehicles found in the video
total_vehicle = (numel(bbox)) - 30;
result3 = insertText(result2, [10 50], ['Total Vehicles = ',
num2str(total_vehicle)], 'BoxOpacity', 1, ...
        'FontSize', 14);

step(videoPlayer, result3);  % display the results

release(videoReader); % close the video file
```