KPMIM SMART PLATE NUMBER RECOGNITION

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KOLEJ PROFESIONAL MARA INDERA MAHKOTA SMART PLATE NUMBER RECOGNITION SYSTEM

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This report is submitted in partial fulfilment of the requirements for the Bachelor of [Computer Science (Computer Networking) with Honours.

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DECLARATION

I hereby declare that this project report entitled

KPMIM SMART PLATE NUMBER RECOGNITION SYSTEM

is written by me and is my own effort and that no part has been plagiarized

without citations.

STUDENT : MUHAMMAD FIKRI BIN JASNI Date : 15 SEPTEMBER 2021

Ts Dr Raihana Syahirah Abdullah

I hereby declare that I have read this project report and found

this project report is sufficient in term of the scope and quality for the award of

Bachelor of [Computer Science (Computer Networking)] with Honours.

DEDICATION

This dissertation is dedicated to my beloved parent for the words of encouragement which help complete my final year project successfully and for their cares and support. Dedication to my supervisor, evaluator and lecturer for giving me the opportunity to be a knowledgeable person. To all my friends for the helps, information shared, moral support and guidance throughout my studying in UTeM.

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ABSTRACT

An automatic number plate recognition system or for short ANPR is a crucial aspect in traffic congestion. The Automatic Number Plate Recognition was invented in 1976 at the Police Scientific Development Branch in United Kingdom. However, it gained much interest during the last decade with the improvement of digital camera and increase in computational capacity. Different kind of violation on the road can be minimize using ANPR system. Many smart cities and integrated parking area are using plate number recognition to control congestion, track violation and more. Plate number recognition is the most cost-effective method that can be implemented for vehicle identification. There are many conditions that need to be consider for implementing this approach such as image quality, car position, light condition and more. This project presents a smart plate number recognition system that will be implemented on Kolej Professional Mara Indra Mahkota which is located at Kuantan Pahang. The system use sensor to detect vehicle that try to pass the access gate. The system will be read the vehicle plate number and check if the plate number is in the registered plate number table which store in the local database. The system also records all the vehicle that pass through the gate so that the college administration can use the data to make analysis. The current work will be implemented with Raspberry Pi based device which is Raspberry Pi 4B and programmed through Python IDE that preinstalled in the Raspberry Pi.

ABSTRAK

Sistem pengenalan plat nombor automatik atau ANPR adalah aspek penting dalam kesesakan lalu lintas. Pengenalan Plat Nombor Automatik dicipta pada tahun 1976 di Police Scientific Development Branch di United Kingdom. Namun, ia semakin mendapat perhatian beberapa dekat yang lalu dengan peningkatan kamera digital dan peningkatan kapasiti komputasi. Pelanggaran undang-undang yang berlaku di jalan dapat diminimumkan dengan menggunakan sistem ANPR. Banyak bandar pintar dan kawasan letak kereta bersepadu menggunakan pengenalan nombor plat untuk mengawal kesesakan, mengesan pihak yg melanggar undang-undang dan banyak lagi. Pengecaman nombor plat adalah kaedah paling jimat yang boleh dilaksanakan untuk pengenalan kenderaan. Terdapat banyak kondisi yang perlu dipertimbangkan untuk melaksanakan pendekatan ini seperti kualiti gambar, kedudukan kereta, keadaan cahaya dan banyak lagi. Projek ini membentangkan sistem pengenalan nombor plat pintar yang akan dilaksanakan di Kolej Professional Mara Indra Mahkota yang terletak di Kuantan Pahang. Sistem ini menggunakan sensor untuk mengesan kenderaan yang cuba melewati pintu masuk. Sistem ini akan membaca nombor plat kenderaan dan memeriksa sama ada nombor plat tersebut sama ada ianya nombor plat yang didaftarkan yang disimpan di dalam pangkalan data tempatan atau tidak. Sistem ini juga merekodkan semua kenderaan yang melewati pintu masuk supaya pihak pentadbiran kolej dapat menggunakan data tersebut untuk membuat analisis. Projek semasa akan dilaksanakan dengan peranti berasaskan Raspberry Pi yang merupakan Raspberry Pi 4B dan diprogramkan melalui Python IDE yang telah disediakan didalam Raspberry Pi tersebut.

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CHAPTER 1: INTRODUCTION

1.0 Introduction

Kolej Professional Mara (KPM) is one of many non-government institutions that managed by Majlis Amanah Rakyat (MARA) that provide diploma and professional certificate to the student. Currently there is six KPM college around the country. Kolej Professional Mara Indera Mahkota is one of the colleges that provide four professional course which is diploma in computer networking, diploma in creative media production, diploma in English communication and diploma in accounting.

Vehicle Plate number is a number on a metal or plastic plate that attach to a motor vehicle or trailer for official identification purpose. Malaysia registration plate are displayed at the front and rear of the vehicle. The issuing of the plate number is regulated and administered by The Malaysian Road Transport Department (JPJ). Plate number also used to identify the vehicle if it is allowed to enter certain compound.

Automatic gate is a gate that use an electric motor to open and close a gate in order to control access into an area or secured compound. Usually automatic gate is used at the entrance to the facilities, and are used to control vehicular access on and off the site. Automated gate also commonly used inside the facilities such as the parking area to separate employee parking area and public parking area. Generally, automatic gate consists of two main components which is the gate and the gate operator. The gate is a physical object that is moved to block the gate opening as open and close action of the gate. The gate operator is a device or machinery that move the gate in and out of the gate opening. The gate operator can be chain-driven, gear-driven, or hydraulic and commonly electrically-powered.

Smart system is a system which able to incorporate function of sensing, actuation and control in order to analyse the situation. Commonly, smart system consists of diverse component such as sensor for signal input, control unit that make decision and instruction, actuator that perform the require action and more. Smart system can be found in many fields such as environment, automotive sector, Internet of Things, and Healthcare.

Effectiveness is an important aspect in smart system, thus smart system needs to be intelligent, instrumented and interconnected. Instrumentation give the system ability to gather data using embedded sensor which is connected by wired or wireless network. For example, smart water meter, electrical power consumption meter and gas meter always monitor the supply and demand for these utilities.

Interconnection act as a link that connect system, people and data thus creating a new way to collect, share and respond to information. Smart system needs to be intelligent in certain ways such as computing models, algorithms, and analytics abilities that will enable the system to make better and more precise decision for business, government, non-profit organization, and individual.

In healthcare, medicine is undergoing a transformation as the technologies in computing and networking become more advances. Smart system is used in healthcare as preventive and personalized to assist the medical workers in hospital to make accurate decision based on data gathered. Decision support for healthcare professional through big data analytics make healthcare services more efficient, high quality and low cost.

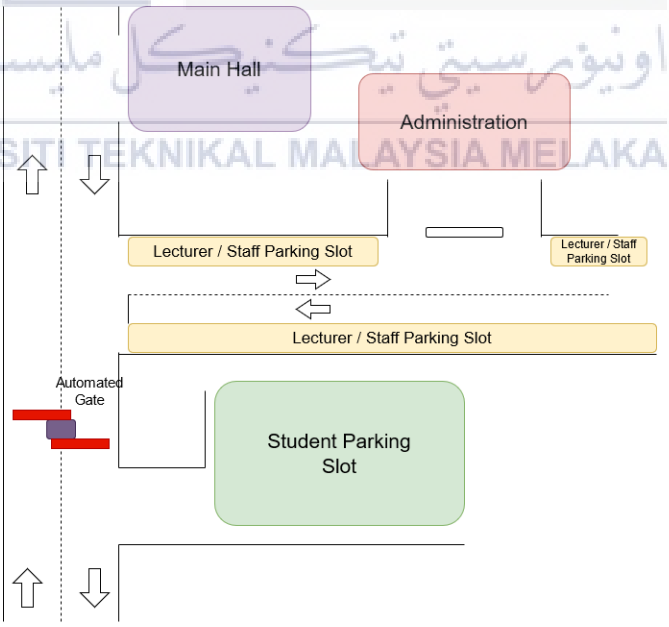
Recognition is the action of recognizing or knowledge that someone or something has been known before and able to recall the identity. In technology, recognition has been used in many ways such as to give access to certain individual or to identify that the person is present and record the data. Recognition is not bound to people, it also uses to recognize vehicle or plate number base on certain country number plate format.

Before biometric recognition was invented, Woody Bledsoe, Helen Chan Wolf, and Charles Bisson pioneered an automated facial recognition in 1960s where a computer was used to recognized human faces. In the early days, the facial features need to be established by human before they could be used by computer. Now, recognition system uses multiple element to be used as identification such as eye, fingerprint, voice and more.

Recognition system is a system that runs recognition programme of human individual, biometrics used as a form of identification and access control. There are many types of recognition system such as Facial recognition system that detect and identify individuals by their facial details. Fingerprint recognition system is a method to verifying a matching between two fingerprints. Plate number recognition system is a system that use an image, and use certain method to detect a words and number in the picture

1.1 Problem Statement

Kolej Professional Mara Indera Mahkota has two types of student which is resident and non-resident. Resident students are the student from year one and two while non-resident students are year 3 and above. Resident students are not allowed to bring their car or motorcycle, however the college has provided a dedicated parking spot for them, alongside with non-resident's vehicle. Meanwhile, for Lecturer and staff, they have their own dedicated parking spot that has been reserved to make sure all lecturer and staff do not have problems when parking their cars.



Problems came across when there is some student that illegally use lecturer's parking spot and forcing them to find another place to park. Because some of the lecturer need to rush, they start to simply park their cars at unsuitable places such

as on the grass and under a tree. The problems become worse when they started to double park their cars and obstructing others. There were also reported that small crash occurs in the tight area once in a while.

In the other hand, the parking slot for lecturer and staff was near to the office main building where all official and very important person (VIP) will use as the main entrance to the administration buildings. This area also being used by student and visitors as their main path from the academic building and administration building. This situation will cause congestion to the traffic due to small area and overload of vehicle in the area. Besides, the congestion become worse when college's bus also needs to access the area to pick up or drop student and staff back from outside event. Student illegally entering the compound using their cars will exacerbate the situation and making it worse to manage.

Currently, the college use automated gate that need an access card in order to open the gate. This system has disadvantages when lecturer or staff do not have the access card whether they loss the access card or they forgot to bring it. In addition, there were reports says that student is able to duplicate the access card and entering the compound freely. This has been happened for a quite some time and causing congestion at the reserved area for lecturer and staff.

Table 1.1: Summary of Problem statement

PS	Problem Statement
PS1	Parking slot for lecturer/staff frequently used by student
PS2	Access card system being compromised where student was able to duplicate the card.

1.2 Project Question

This project is aimed to develop a product and a system that can overcome all the problems faced in current system. The product also needs to be innovative and

suitable to be applied at the targeted area. Project question is needed to clarify the main requirement of the project before implementing.

Table 1.2: Summary of Project Question

PS	PQ	Project Question
PS1	PQ1	How to avoid student from using lecturer and staff parking spot?
PS2	PQ2	How to improve access card system?

1.3 Project Objective

Table 1.3: Summary of Project Objective

PS	PQ	PO	Project Objective
PS1	PQ1	PO1	To investigate current automated gate parking slot system.
PS2	PQ2	PO2	To develop a plate number recognition system as identification.

PO 1: To investigate current automated gate parking slot system. There are many weaknesses in the current automated gate system that contribute to other problems in the college. The system should give access to lecturer and staff while restrict student to enter the compound.

PO 3: To develop a plate number recognition system as identification. The recognition system will give access registered plate number which is belong to lecturer and staff. This system eliminates the access card that easily being infiltrated.

1.4 Project Scope

The main purpose of this system is to provide an automated access gate system that use plate number recognition to give authorization into the vehicle restricted area. The Plate number recognition technology used in the automated gate system

provide a higher level of security and restriction because student cannot access the restricted are with their cars. Besides, they cannot change their plate number as it is considered against the law.

This project will focus on automated gate system that use plate number recognition as identification. Resources for this project will be the main control unit which is Raspberry Pi that use Raspbian operating system. A camera that will be used to record and capture the image of the plate number, and python coding that will process the image and detect character based on the image captured.

The user for system is focused on Kolej Professional Mara Indera Mahkota lecturers and staff. All lecturer and staff need to declare and register their vehicle before the system is implemented on site. Any user other than lecturer and staff of the college need to have special privilege or permission from the administration to get access through the smart plate number recognition system.

1.5 Project Contribution

This project has many advantages to the college and it contribute to many aspects. The current access gate system can be enhanced and improved by implementing this system. Furthermore, this project able to cover flaws that unhandled by the current access gate system. This project based on the idea of providing more intelligent system that was able to detect and decide the appropriate decision to be made.

Table 1.4: Project Contribution

PS	PQ	PO	PC	Project Contribution
PS1	PQ1	PO1	PC1	Manage and control the use of vehicle by student in the essential college's area.
PS2	PQ2	PO2	PC2	Reduce the number of traffic user in the targeted area.
PS3	PQ3	PO3	PC3	Provide smart and efficient way to authenticate user through the access gate system.

1.6 Project Organization

Chapter 1:

In this chapter mainly focus on this project's introduction which include the project background and the project to be developed. In this chapter also explained the problem statement, objective, scope, outcome and conclusion. This is for establish base idea and overall project.

Chapter 2:

This chapter about reviewing others previous project that related to this project. Focused on reading material and published thesis explanation. This chapter also describe related published thesis, journal and articles about recognition system, ANPR, recognition algorithm. Those paper are analysed to extract valuable information for this project.

Chapter 3:

Project method are explained in this chapter which describe phase and stages in completing this project using selected methodology. Milestone also describe in this chapter which give the full timeline for the project's progress.

Chapter 4:

In this chapter, problem analysis, analysis requirement and design are being discussed in detailed manner. Problem analysis from chapter 1 is discussed in this chapter as well as analysis requirement, which consist of software requirement and hardware requirement. Design of the project include circuit diagram, logical design, physical design and flowchart.

Chapter 5:

This chapter mainly focus on the testing phase for the project. Testing plan, test design and analysis of the project. Testing plan consist of test organization, environment and schedule. The test result then will be analysed for testing phase.

Chapter 6:

This chapter discussed about the overall summary of the project which consist of observation both strength and weakness of the project. Improvement for the project also being discussed for future works.

1.7 Conclusion

In conclusion this chapter describe the overall details and general understanding regarding the project purpose, aim, reason and impact of the project on targeted audience. The next chapter will be literature review which to identify related work and issues related to the project.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

In a project development, literature review is one of the important parts because identifying information that are related is required to help in the project. Plate number recognition that currently develop or research will be discussed in this chapter. Providing a more understanding regarding to this project is the main focus of this chapter. In order to meet the objectives and scope of the project, literature review is the best way because it can provide strong evidence to support implementation on project justification through this method.

Figure 2.1 shows the subtopic for this chapter. Subtopic that will be discussed includes the Introduction, Plate number recognition, Microprocessor and microcontroller, sensor, Communication and Related works. The main objectives for this research is to give ideas and knowledge that can be used to develop smart plate number recognition system.

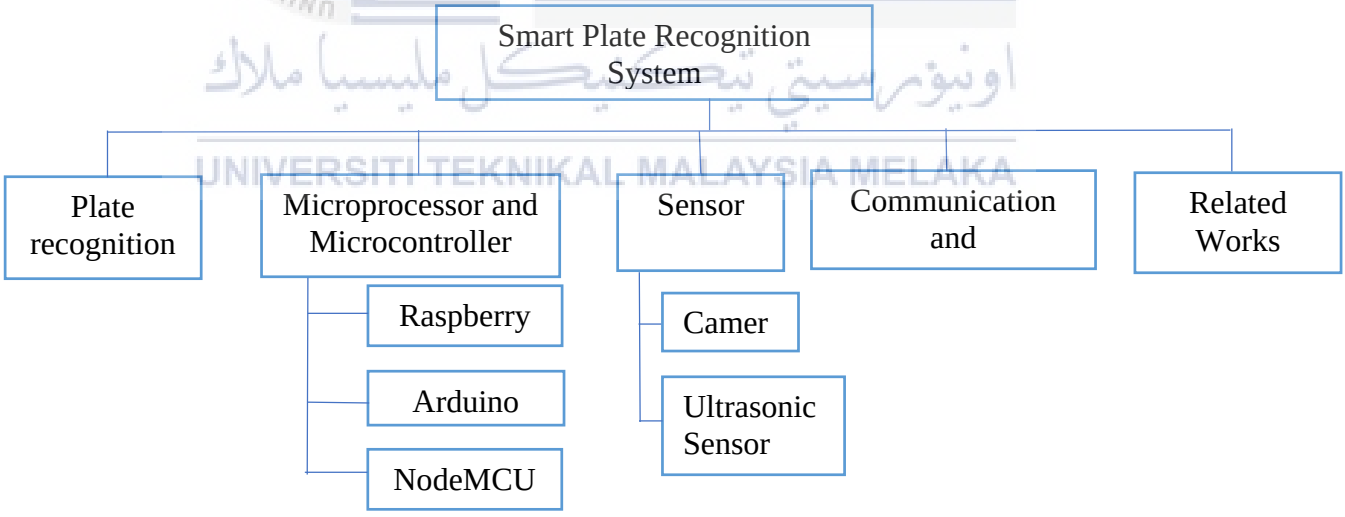


Figure 2.1 Overview of Literature Review

2.1 Plate Recognition

License Plate Recognition is a technology that able to automatically recognized any character from video footage or picture captured for security or traffic analyse

purpose. Character recognition algorithms for License Plate Recognition are used for many intelligence infrastructures such as electronic payment system and arterial management system. License Plate recognition also known as LPR compose of three processing steps which is extraction of license plate region, segmentation of the plate character, and recognition of each character. The true recognition rate and error recognition rate relies on the first two steps which are incorporate with image processing technique on a still image or frame sequence from a video.(Anagnostopoulos et al. 2008)

Algorithms that being used for plate recognition is Automatic License Plate Recognition (ALPR) and the approach vary based on condition such as image quality, car position, light, single or multiple image and more. Besides effectiveness, License Plate recognition also cost-effective technique that can be used for vehicle identification. There are many types and variation of plate number format as well as environment cause challenges in the process for plate detection. Plate variation such as location is the car plate exist in different location on each image. An image may content many or no plate number is under quantity variation. In addition, size may be differed as the size of the plate in an image depends on distance and zoom factor. Plate may have variation in character and background colour due to plate type.

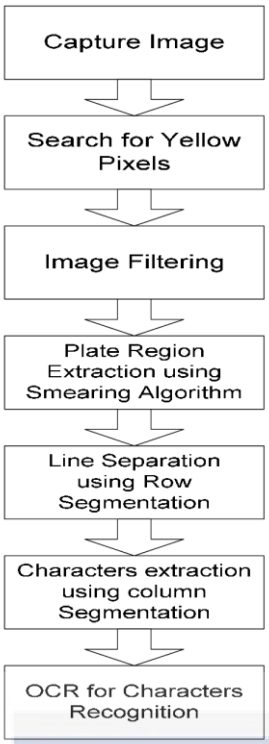


Figure 2.2 : System flow

Plate number in different nation may be written with different fonts and language. Standard and vanity such as there are plate number that customized and not following the standard format. Plate number may be covered by dirt or broken, tilted or changed position, and lastly plate may have others variation such as frames and screw. (Qadri and Asif 2009)

2.2 Microprocessor and Microcontroller

2.2.1 Raspberry Pi

Raspberry Pi is a low-cost Single Board Computer (SBC) are designed to improves computer education especially pre-university level. The Raspberry Pi is a system on chip (SoC) which is a single board carries all the essential circuit. For example, the Central Processing Unit, Graphic Processing Unit, input, output and processing circuit are carried in the same board. Raspberry Pi able to programming hardware, driving electronic circuitry and collect data through various ways because the availability of General Purpose Input Output (GPIO) pins features.

Figure 2.3 : Raspberry Pi

In addition, Raspberry Pi adaptable with a keyboard, mouse and display monitor with HDMI cables. The first generation of the computer came with SD card slot that can be used to boot Linux operating system which is Raspbian OS. Newer generation computer have micro SD Card slot replacing the previous SD Card slot. (Yamanoor and Yamanoor 2016)

2.2.2 Arduino

Arduino microcontroller is an open source platform. Arduino provides strong base for hardware and software. There are many various of Arduino board such as Arduino 101, Arduino Zero, Arduino Due, Arduino Yun, Arduino Leonardo, Arduino Uno and more. All various board have different specification in terms of hardware and user base application. In year 2005, some research students at Interaction Design Institute in Ivrea, Italy start the Arduino project to provide a platform for Hobbyist, Embedded System Professionals and Developers to creatively create project by integrating various device such as sensor and actuators.

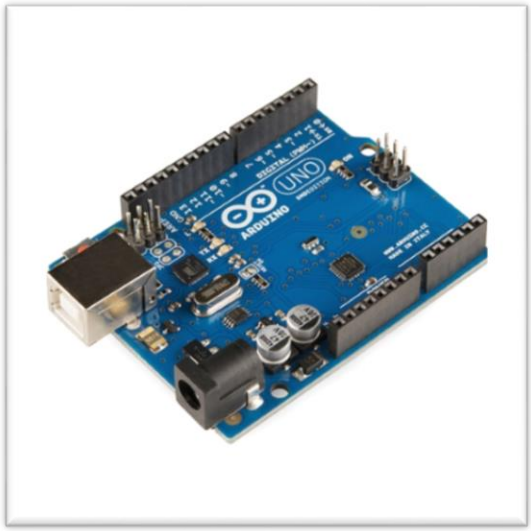


Figure 2.4 : Arduino UNO

Arduino has a strong Integrated Development Environment (IDE) used by all researcher because it is platform independent base for Arduino hardware as well as able to run on multiple operating system platform. The IDE was cross platform application based on Java Technology. (A. Nayyar and V. Puri 2016)

2.2.3 Node MCU

Node MCU is simply a paring of firmware and hardware based around the esp8266-12e module which is a low-cost Wi-Fi enable microchip with a full TCP/IP stack and microcontroller capabilities. The developers originally tied the term node MCU to their open source firmware which ran on the esp8266-12e based development kit. As time passed, the name node MCU become common with the development board. In the early days, user can programme the board using the lua programming language but as the open source community wrote libraries, the programming language fell out of favour. The libraries allowed the board to be programmed with the Arduino IDE using the more popular Arduino programming language.

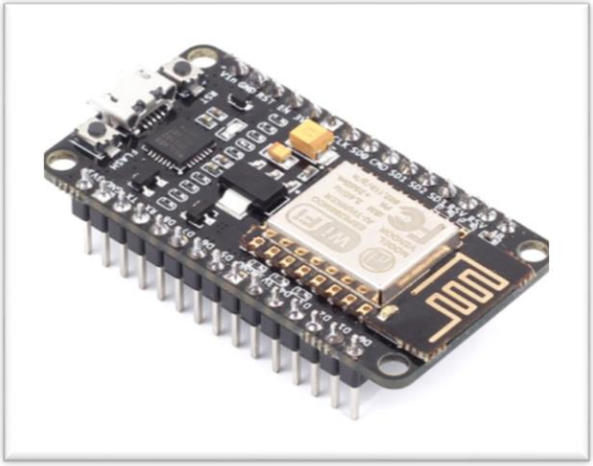


Figure 2.5 Microcontroller

Compatibility with other languages such as micro Python has been integrated. This cause the popularity explosion of the node MCU development board being manufactured by online electronic retailer. In addition, node MCU is a system that has integrated features like a microcontroller with a communication chip used as an IoT support device. (Rasyad, Murti, and Rizki 2019)

2.3 Sensor and Camera

Sensor is a type of device that are able to detect certain type of signal or input from the physical environment. Example of the environment input are pressure, heat, light, moisture, and many others. Sensor also able to send signal to some type of controller to present the output of the reading.

2.3.1 Raspberry Pi Camera

The camera module capable of taking stills photograph as well as high definition video. It is used by advance user and beginners as the module is very easy to handle. Most of Raspberry Pi version are compatible with the camera module and it can be access through the MMAL and V4L APIs.

2.3.2 Ultrasonic Sensor

Ultrasonic sensor is a transceiver module that is it contains both transmitter and receiver modules in it. The transmitter transmits high-frequency ultrasonic waves when powered. When an obstacle near in the front of the sensor, the waves reflected back to the sensor. The receiver intercepts the reflected waves and the sensor able to measure the distance based on the reflected waves received. Due to its simplicity, this sensor is widely used in mobile robot applications to acquire environment features and mapping. (Visvanathan et al. 2011)

2.4 Communication and Networking

2.5 Previous Development

2.5.1 Detection and Recognition of Multiple License Plate from Still Images

According to (Menon and Omman 2018), the focus of the paper is to design an efficient car license plate detection and recognition system. The system mainly aims on detection and recognition of multiple cars license plate from a single frame. Detection process based on mix of mathematical morphology features and edge statistic produce high standard result. The design use ALPR algorithms which the main steps divided to two parts, plate detection and plate recognition. The system uses an infrared (IR) camera to capture still images. Under plate detection stages, it is divided into multiple sub segment.

- Grey Scale Conversion

  This will change the colour of the image to grey scale image to easy the process of finding vertical edges and remove the portion of the images that does not contain any of the vertical edges. Grey scale conversion will remove all noise in the image.

- Sobel filter

This step will find the vertical edges on the images. The first horizontal derivation will be calculated in this steps and Gaussian smoothing combined.

- Threshold

  Threshold filter is the simplest segmentation method using Otsu's method. This method determines the optimal threshold value.

- Morphological Operation

  This step divided into two which is erosion and dilation. This process will have the possible areas that can contains plates number. Object in erosion white is smaller and process is obtained by the dilation od an image and followed by an erosion. This process is useful to remove small holes in dark region.

- Contours

  Contours function can be use to find the portion of the images that contains plate number and extract the bounding rectangle. Area and aspect ration use to detect license plate. Aspect ration calculated by plate width divided by plate height using flood fill algorithm.

- Support Vector Machine (SVM)

  Applying support vector machine (SVM) algorithm to predict if each region is or is not a plate. Supervised learning use labelled data for learning procedure and train the classifier in the classification process (Menon and Omman 2018).

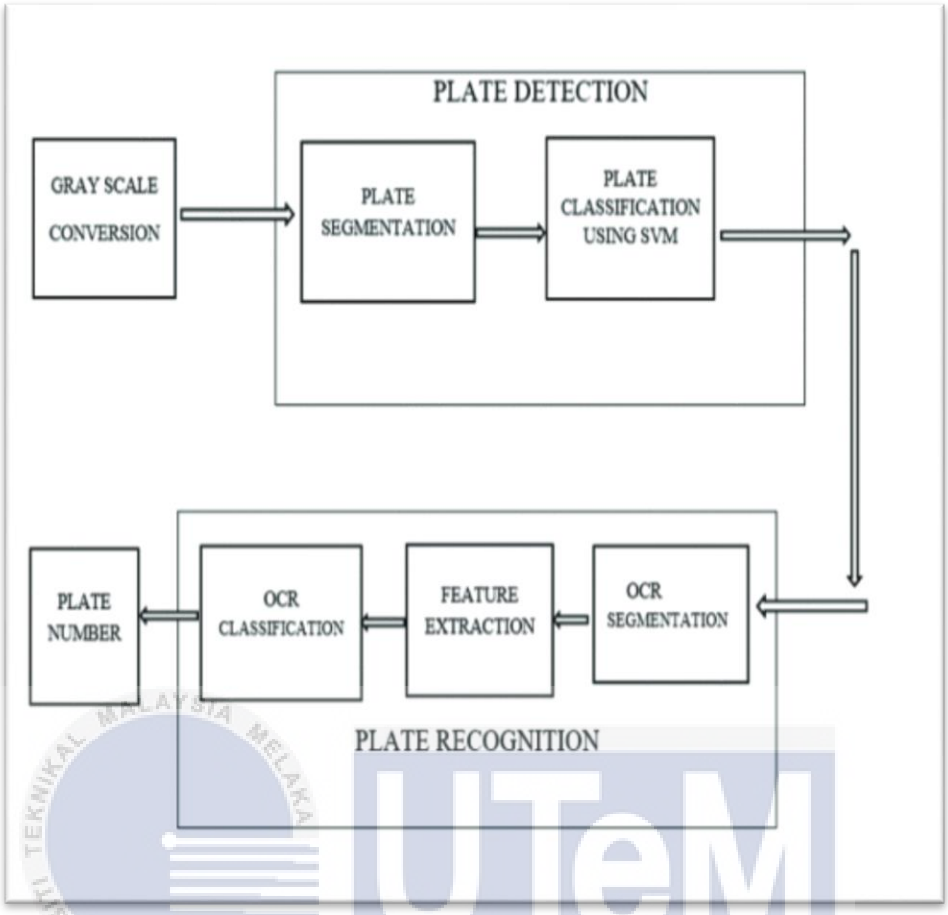


Figure 2.6 : Overall Design

The second stage of the system is plate recognition. After the image has been processed to identify the plate location on the image, the plate for each character is proceeded to segmentation, and machine learning algorithm in order to predict the character. In the proposed system, for plate recognition, Artificial Neural Network (ANN) will be use. The whole system is implemented on PC with intel i5 as the CPU. The algorithm developed with c++ on windows operating system with OPENCV 3.2.0 library.

2.5.2 Effective algorithms and methods for automatic number plate recognition

According to (Beibut, Magzhan, and Chingiz 2014), the aim is to propose a method to solve the automated plate number recognition problems and test the proposed algorithm by presenting the evaluation result. The main focus of the algorithm is detecting plate number area in a frame, segmentation and extraction of character from plate number and lastly using an optical character recognition in order

to extract character or symbol. The algorithm use in plate area detection quite different but there is similarity compared to other algorithms.

- Grayscale
- Blur
- Vertical edge detection
- Close morphology
- Find contours
- Find correct candidate

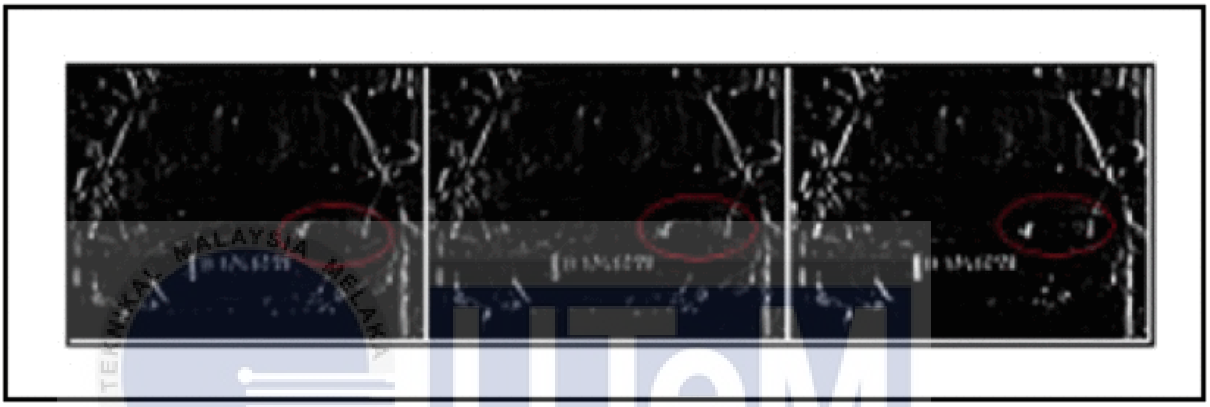


Figure 2.7: The difference among vertical edge detectors

Segmentation stage is needed to extract plate character after the plate area are determined. The algorithm selected to be used in segmentation is based on finding contours that looks like a character. This algorithm works better compared to another one commonly used algorithm which is based on projection of image into X axis (Beibut, Magzhan, and Chingiz 2014). Before extracted, the image needs to be converted into binary format. Recognition process used modified version of INN algorithms where the character was divided into 49 subparts. White pixel will be counted in each subpart.

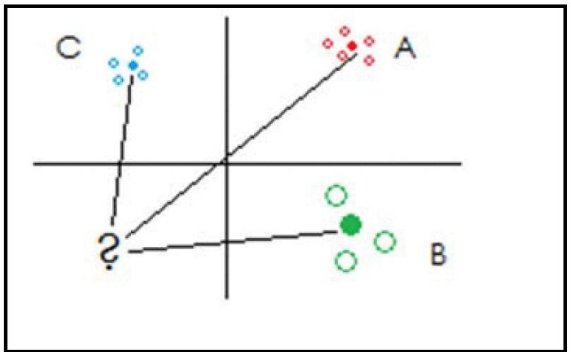


Figure 2.8: INN for optical character recognition

2.5.3 Automatic Number Plate Recognition System for Vehicle Identification Using Optical Character Recognition

Based on (Qadri and Asif 2009), the objective is to use the vehicle plate number as vehicle identification in designing an effective automated authorized vehicle identification system. Typically, area such government office, parliament, supreme court, and military zone are implementing the system on the entrance of the area to highly restrict access from public. Images will be captured as the system detect the vehicle then plate number is extracted using image segmentation. Optical character recognition technique is used to identify every single character.

The most important part of this system is software model which will use series of image processing technique. The algorithm is divided into three parts:

- Capturing images
- Extracting the plate from image
- Recognize the number from extracted plate

USB camera is attached to a computer unit and used to capturing images in RGB format. Extraction begins with yellow search algorithm as the system is used to match the Sindh plate number format. Plate number of Sindh has yellow background with alphanumeric character written in black. The images captured after the search algorithm is in black and white before moving to next filtering technique. Next steps consist of two different filtering technique to extract the plate number. First technique is to remove all white patches that are connected to any border and set their pixel value to 0. Next filtering technique is to use pixel count method in order to remove small regions in an image other than the plate region. Smearing algorithms is used to search or the first and last white pixel starting from top left corner of an image. The plate number in the image then cropped.

Last part in the software model is to recognize the character from extracted plate number. Optical Character Recognition algorithm is used in this system by inverting the cropped image. Line separation process is applied before the Optical Character Recognition take place. The individual lines in text are separated which adds each pixel value in a row. If the sum of a row is zero means that the row does not contains any character while if the sum of a row is greater than zero means the row consist of character in it. Then, the line separation is applied column wise to separate the individual character. The OCR now used to compare individual character against complete alphanumeric database to identify the character.

In the hardware model of this system, it consists of sensor, camera, motor that control the barrier, computer unit for algorithm execution, and microcontroller for controlling the complete hardware of the system.

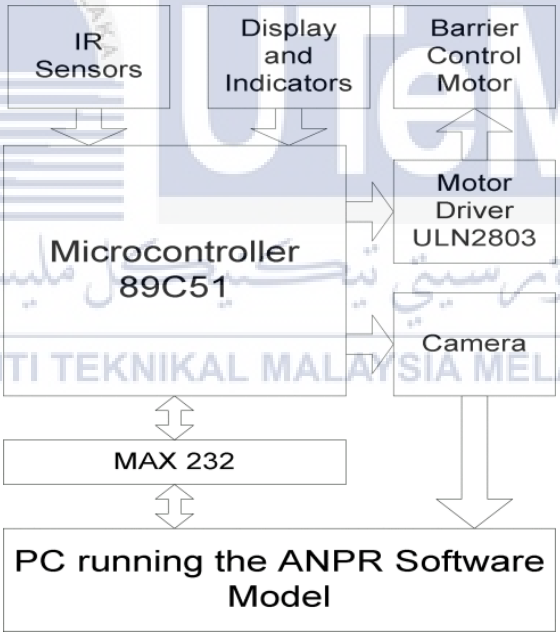


Figure 2.9: System Design

In this proposed system, a PC running Matlab is used for the image processing phase which was captured by the USB camera. The system use yellow search algorithm first on the image which will detect the area of the plate number in the image (Qadri and Asif 2009). Next, the system use an algorithm to extract the character consist on the plate and convert it into binary format. In order to extract individual

character, row and column segmentation method are used. Lastly, for character recognition the system use OCR in last phase of recognition process.

2.5.4 Automatic Number Plate Recognition

Referring to (Nayak et al. 2020), number recognition system uses image processing concept to fulfil the needs in security system for certain area. Reading the image of vehicle plate number also applied the same scheme which is optical character recognition. Example implementation of this system is allowing vehicle to pass through toll by plate detection automatically. Besides, provide them with pay-slip after detecting the plate number then open the road to particular vehicle. This system also used in parking area to allow vehicle to enter and park their car without present or control by the authorities.

In this system, a monochrome camera along with colour camera is used. Before plate identification can be certified, number plate area needs to be found first. Three processing categories in order to trace the number plate's position. Crucial method for recognition character is character separation which some process uses pattern image, grayscale and colour. By separating the character, the system can match of template or learning base classification.

2.5.4.1 Binary Image Processing

Combination of edge statistic and morphology technique used in this method to mine license plate region from the background or the other area of the car. This process has high recognition percentage. In the other hands, this method require time to complete as it process all the binary object and become inaccurate when there is another text on the plate.

Figure 2.10: Binary image processing result

2.5.4.2 Adaptive Thresholding

The image need to be converted into grayscale first. This method is for creating binary image. Basically, threshold value is calculated and compared to each pixel. The pixel will be replace by black pixel id the value less then threshold value. The pixel will be replace by white pixel if the value is greater than the constant.

2.5.4.3 Contras Extension

Histogram equalization process is needed to expand the contrast of the image. Sharpness of the image will increase when undergoes contras extension process. Quality of fmage which has very poor contras can be increase by histogram equalization. Four steps include in this process are:

I. Sum up all the histogram values
II. Dividing the value with total number of pixels
III. Enlarge the value with highest grey level value
IV. Chart the new grey level value

2.5.4.4 Median Filtering

Removing the undesirable noises in the image which is matrix od 3x3 is passes in the image. The dimension can be adjusted according to the noise level. Sorting of all the pixel value orderly and replace the pixel.

2.5.4.5 Character Segmentation

Using MATLAB function which is Regionprops, each character is separated by defined box in from the plate region. Regionprops function return the smallest defined box that contains a character.

2.5.4.6 Feature Extraction

From the segmented plate number, feature extraction process will find, mark and save all the features. Zonal density feature are use to recognize the character. Two different area can be found in zonal density function. In 16 zonal, a 32 x 32 image are divided so that in the image there are 16 features.

2.5.4.7 OCR by Template Matching

Template matching is one of the character recognition technique. Template are created for every possible input character using the regular font style. In this case, plate number always alphanumerical which is A to Z and zero to nine.

2.5.5 Vehicle number plate detection and recognition using bounding box method

According to (Babu and Raghunadh 2017), image processing technology that recognizes the authorized vehicles using certain method to detect their license plate with no direct human interaction can be called license plate number recognition system. Application such as speed control, identifying stolen car, traffic control, toll gate and security application can implement license plate detection system. Four main phase that make up the system are pre-processing, plate region extraction, character segmentation, and character recognition.

2.5.5.1 Pre-processing

Pre-processing phase require the system to capture video or still images of the vehicle using camera, whose vehicle number plate to be identified. However, if the source is in type of video, the system should choose frames that have the clearest image in that frames. The image then converted from RGB image to grey scale image using specific

equation to easy the plate extraction process. Enhancing the plate recognition by using median filter which was aim to erase all noises.

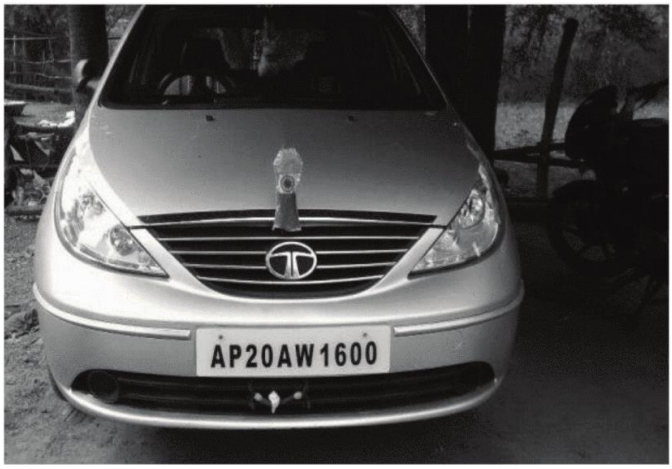


Figure 2.11: Example of grey scale image

2.5.5.2 Localization of the License Plate

In the digital image, the system needs to identify the exact location of area that is plate number. Sub-image that contains a plate number should be the result of this phase. Two phases are needed to achieve the goals which is:

identify license plate exact location

determining bounding rectangle over license plate

Identifying the boundaries in an image using sobel edge filter that able to detect the edge when there is sharp variation in intensity gradient in an image. Identifying edge helps preserve the structural properties of an image and reduce the data by removing the unnecessary information.

Figure 2.12: Example of sobel edge filter

2.5.5.3 Character Segmentation of the Plate Number

The system scans for connected object in an image right after the plate number was successfully extracted. Special label is assigned to each connected component identified in the image. The plate number then will be divided into multiple sub-images representing each character that have different label. Recognition process will be not accurate if the segmenting process is not done properly. Bounding box method come in handy to avoid this problem where bounding box method will enclose the labelled region completely with rectangular box.

Figure 2.13: Example of bounding box

2.5.5.4 Character Recognition of the Number Plate

Character recognition is the next step after segmenting the plate number into individual character. Conversion of image text to character is the main goal in this step. Alphanumerical database is used to completely compare each of the character from the licence plate with template. This method is call template matching and it is one of the optical character recognition method that have high recognition accuracy (Babu and Raghunadh 2017).

2.6 Critical Review

Referring on the current paper and project review as well as equivalent system that have been research, numbers of element and features can be compare to distinguish each of the literature. Improvement for the project to be develop is the main aim in making this comparison. Basically, current project that has been research mostly

use same overall concept and phase to recognize the plate number. Most of project prefer to use Artificial Intelligence in order to detect the character. However, there is multiple different algorithm that being used to extract the plate number area before character recognition process begins. Different algorithm also being used due to the nature of the project implementation because plat number format is different in certain country. Therefore, optimizing the algorithm to suit the plate number formatting are crucial for more effective process. In addition, there are projects that need a certain paid software for the image processing phase where some other project uses open source programs and algorithm for the image processing phase.

Table 2.1: Comparison of literature review

Journal Title/Author	Computing device	Sensor and camera	Algorithm/method used	Functionality	authorization
Detection and Recognition of Multiple License Plate from Still Images	Intel i5 CPU, Windows OS	Infrared sensor	• Grey scale conversion • Sobel filter • Threshold • Morphological operation • Contours • SVM	The system mainly develops for Spain and Indian type of plate number recognition. Dataset being used to test the recognition result.	no
Effective algorithms and methods for automatic number plate recognition	Undefined computing device	General purpose camera	• develop own algorithm • grey scale • blur • vertical edge detection • morphology • find contours	The system focusses on software and algorithm functionality where image being capture beforehand and	no

				processed to extract the plate number.	
Automatic Number Plate Recognition System for Vehicle Identification Using Optical Character Recognition	Microcontroller 89C51	Infrared sensor USB camera	• Yellow search algorithm. • Row and column segmentation	The sensor detects any vehicle near the entrance, the send signal to PC for capturing images. The algorithm then extracts the plate and compared to database for authorization.	yes
Automatic Number Plate Recognition	Not mention any computing device.	Monochrome camera and colour camera	• Binary image processing • Adaptive thresholding • Contras extension • Median filtering • Segmentation	Focusing in plate number recognition algorithm. Used to detect plate number in a pre-collected image of vehicle. Use template matching for better recognition accuracy.	no

Vehicle number plate detection and recognition using bounding box method	Not mention any computing device.	Any capturing device	• Grey scale • Median filter • Sobel edge filter • Bounding box • Template matching	Detect and recognize plate number in a still image using bounding box method	no

2.7 Proposed Solution

Based on the literature review done for this project, there are many aspects that can be improved from the current related project. However, there are also some of the element that can be implement into this project. Referring to the paper reviewed, most of the system are software-based system that usually require a set of computers or any device that run an operating system which commonly windows. The system does not have any specific device that mention as the computing device. Thus, implementing such system require specific space to store the computer unit such as dedicated room or similar.

In addition, there is a project that prefer to used microcontroller 89C51 which unable to run the software or algorithm used. Instead, the system requires another set of computers to store and run the algorithm. Used of microcontroller is a good option because it able to control multiple sensor and device. In the other hand, the system needs another PC for the software to run. Most of the project focusing on the software aspect such as algorithm and methods used. Only one project that use a database for authorization to allow or deny access for certain vehicle. However, the server was store in the PC which the data ned to be sent from microcontroller to the pc.

The proposed project is aim to overcome certain problems and suitability issue from the current related system. Proposed project is plate number recognition system that can authenticate and authorized registered vehicle belongs to the lecturer and staff of the college. The project use raspberry pi 4 B for the main component of the system. The reason Raspberry Pi is very suitable for this project is the versatility of the

computer despite the size compare to others microcomputer. Raspberry Pi able to act as a computer and a microcontroller in the same time with higher computing capabilities. Raspberry Pi come in handy because it has its own camera module that can be used in this project. Small size of the device enables it to be place in small area such as automated gate post. Overall review seems to agree that use of artificial intelligence for optical character recognition in the system give huge advantage.

2.8 Conclusion

This chapter is discussing about existing project and previous project review to dig and discover important element in this project. Previous project that has been discussed have some issue that need to be improved while some of them are good and need to be implement in this project. Literature review consist of gathering data, information, analysis and requirement. Data collected is being used to draw conclusion and analysis thus identify the recommendation for this project. In the next chapter, project methodology is discussed in detailed.

CHAPTER 3: PROJECT METHODOLOGY

3.0 Introduction

Project methodology and project milestone is discussed in this chapter. Before implementation of a project or research can be done, project methodology needs to be complete because project methodology is a set of process, method, tools and documentation that helps clarify how overall stages of the project will be conducted. In other words, by collecting data, analyzing data and model design, it helps the developer in planning and schedule the project, thus making the project process systematic and organized. Milestone is a mark on specific point along a timeline that refer a significant stage or event usually may signal anchor such as a project start and end date, external review or budget check. Always keep up with the project development and follow up the milestone is very important for the project developer. In order to make sure the project is completed within allocated time, all activities are listed in the milestone.

3.1 Project Development

In project development, the main focus is to put together and gather all the fact, figure and findings relevant to the development of Smart Plate Number Recognition System project through articles, journals or website. In addition, likewise offer the solution from previous existing project and provide improvement with different method applied consider as the goal for the project development.

3.2 Project Methodology

This project use Rapid Application Development model (RAD) which is prioritizes fast prototyping and quick feedback. This model have huge advantages compare to common waterfall model which is very popular and being used widely. Main flaw in the waterfall model is when then program reach testing phase, it is difficult to change core function and features of the software based on evolving requirement. There are four phase in RAD which is define the requirement, Prototype, Feedback, and Finalize.

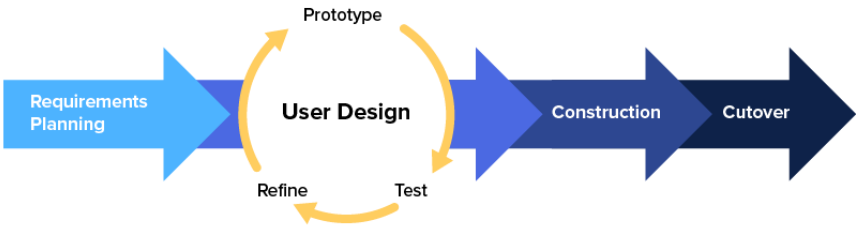


Figure 3.1: RAD diagram

3.2.1 Phase 1: Requirement and Planning

In order to determine the project requirement for the final product, RAD model must start with the planning. Discuss the definition of the system as well as the software and hardware requirement are the main objective of this phase. In addition, understanding the task and requirement is very important before moving to implementation phase of the project. All the requirement for the project is discussed as below.

System requirement :

i. Capturing image module

The system must be able to capture a picture in order to get a frame to obtain the pate number. The system capable to identify the plate of a vehicle in the captured picture with different angle and distance of the vehicle in the picture. The system also needs to be able to detect the present of any vehicle in the capturing spot.

ii. Processing image module

Using the captured image, the system needs to process the image in order to differentiate the significant pixel area in the image that consist plate number. Unwanted area and insignificant pixel that do not consist any plate number information should be ignored. The plate number area needs to be isolate for further process.

iii. Recognition module

The system able to recognize correctly the character that being captured by the camera. Recognition algorithms in the system must be able to undergo the

recognition process in short amount of time and effectively detect each of the alphanumerical combination in the plate number.

iv. Decision module

Using the result gathered from the recognition process, the system must be able to compare the result against any local memory or database as reference in order to make decision. The system should be able to distinguish registered and unregistered plate number. The system must be able to give permission or deny any vehicle based on the comparison on stored data.

Software Requirement :

i. Raspberry Pi OS

Figure 3.2: Raspberry Pi OS

Raspberry Pi Foundation has provided the raspberry Pi OS as the primary operating system since 2015 for single-board computer in Raspberry Pi family. Raspberry Pi product of compact computer already highly optimized with Raspberry Pi OS and ARM CPUs.

ii. PhpMyAdmin database

Figure 3.3: MySQL Database

Free software tool that support operation on Maria DB and MySQL, phpMyAdmin is a free software tools that allows user manage MySQL over the Web. Basic operation for managing database easily performed by the user interface at the same time user able to execute SQL statement.

Hardware requirement :

i. Raspberry Pi

Figure 3.4: Raspberry Pi 4B

The figure shows Raspberry Pi computer version 4 B which an upgrade from previous version. The computer is now support dual monitor and memory up to 8GB DDR4 of RAM. Comes with 2.4/5GHz Wi-Fi adapter and Bluetooth 5.0 built-in onboard. Provide two 2.0 USB and two 3.0 USB port that capable for higher data transfer rate.

ii. Ultrasonic Sensor

Figure 3.5: Ultrasonic sensor HC-SR04

Consist of a transmitter and a receiver in the front to calculate time taken for a signal to reach object. The sensor is small and cheap provide easy to use in any project. Works with 5V logic and comes with four pin which is VCC, TRIG, ECHO and GND. Signal from computer inbound through the trigger pin to make the sensor transmit a signal. The sensor uses echo pin to send signal back to computer.

iii. Pi Camera

Figure 3.6: Pi Camera

Raspberry Pi camera is an official Raspberry Pi product that compatible with the computer lineup. The camera module uses ribbon cable to connect to the Raspberry Pi computer. It has 5-megapixel OmniVision OV5647 sensor.

iv. Breadboard

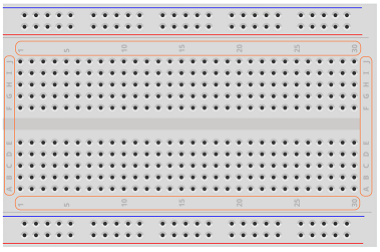


Figure 3.7: Breadboard

Breadboard is used to hold electronic component such as LED, resistor, transistor, chips and others. It consists of plastic material and metal clip inside to hold

component strong enough so that the component stays on it place and easy enough to make adjustment and correction.

3.2.2 Phase 2:User Design and Prototype

Creating the system design for the project need careful studies about the requirement specification from the first phase. This section focusses on discussing the project architecture, user design and prototyping. Using the requirement specified from the previous phase, the design help to define the overall system architecture. The prototype uses ultrasonic sensor to detect any present of vehicle in the capturing distance and use an LED to mimic the gate arm. After detecting the vehicle, Pi camera will take an image and send to the single-board computer to be process. Image processing algorithm will identify the plate number in the image and recognition algorithm will extract the character from the plate. The result from the process then will be compared against local database where all registered plate number are stored. If the result from the recognition process match to any plate number stored in the database, the system will open the gate arm to allow vehicle pass the gate.

3.2.3 Phase 3: Construction

A software call Thorny Python was provided and pre-installed in the Raspberry Pi OS which is used to develop the program from the project. The infrared sensor and the Pi Camera are tested with the coding written earlier to make sure the sensor function as expected. The algorithm will detect plate number area in the image and the recognition algorithm will identify the character in the plate.

3.2.4 Phase 4: Testing and Cutover

After the hardware, software and functionalities of the system is tested, the system is ready for deployment. Once the system passes all the test and attempt in previous phase, the system now can be used in real environment. In order to keep the system's functionality and hardware's functionality, maintenance phase need to be applied. The focus of this phase is to monitor the product that already used in real environment.

3.3 Project Milestone

Project milestone is a task that shows a specific important achievement in a project with zero duration to ensure project completeness. In order to make sure the project completion, the milestone flow should be clear and accurate.

Table 3.1: Project Milestone

Phase	activity
Phase 1	Discussion on the main idea Preparing the project proposal submission and approval for the proposal Proposal correction Discussion on requirement Discussion on objective, scope and problem statement
Phase 2	Design the project architecture Develop the project flowchart Discussion on related works of proposed system
Phase 3	Coding and implementing the proposed system Assemble the sensor and camera on the single-board computer Develop the prototype
Phase 4	Check for error and bug in prototype Develop test case Test the prototype
Phase 5	Test prototype with user Collect user feedback
Phase 6	Continually monitor the product

3.4 Project Gantt Chart

Table 3.2: Project Gantt Chart

Task Name	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Phase 1															
Phase 2															
Phase 3															
Phase 4															
Phase 5															
Phase 6															

3.5 Conclusion

Methodology for this project is explained in detailed in this chapter. This chapter also describe the used of Rapid Application Development method for this project in terms of structure, method and each phase of the model. Every activity in each of the phase is discussed and explained to give full understanding of the methodology used. Project milestone is used to make sure this project follows the time given to finished and not extending any of the time frame given. Next chapter will discuss the problem analysis, hardware, software and design of the project.

CHAPTER 4: ANALYSIS AND DESIGN

4.0 Introduction

All analysis activity that involved in the design phase will be discuss in this chapter. The requirement information used in plate number recognition system such as hardware requirement and software requirement are stated. The requirement is very important to be identified before implementing the project because it will give the clear picture on how the project will be and what are needed for the project to be successful. The project architecture such as process diagram will be discussed in this chapter including overview on how the system function in real environment to give full understanding of the system flow.

4.1 Problem Statement

Problem analysis of this project is the student of KPMIM frequently bypass the current automated gate system where give them access to restricted area where it is illegal for student to dive or ride a vehicle in that particular area. This situation contributes to congestion in lecturer and staff area in front of the administration building. In addition, lecturer and staff need to have the access card whenever to pass the gate. This is quite unpractical because sometimes they forget to bring the card and stuck at the gate because the road in that area are one way and narrow. They need to call the security guard to assist them whether to open the gate or to reverse their vehicle.

4.2 Requirement Analysis

Requirement analysis for this project is important and required as it is a process to determine the needs and condition of the project. There are several things such as data requirement, functional requirement, non-functional requirement, hardware and software requirement that will be discussed. This gives the overall picture of all required element to be consider in developing this project.

4.2.1 Data Requirement

Since the system will interact with hardware, design for the system should consist of input and output data flow that is collected and performed by the hardware such as pi camera, ultrasonic sensor and the gate arm. The pi camera is used to capture the image of any vehicle that are within the capturing range. The capturing range is determined by the ultrasonic sensor that detect any vehicle within preconfigure range. The data is then send to the microcomputer to process and identifying the plate number and compare the result against local database. Based on the comparison result, the system will make decision to give or not giving access to the vehicle.

4.3 Technical Requirement

In order to complete the project technical requirement, need to be discussed and considered. There are three requirements under technical requirement which is hardware requirement, software requirement and cost analysis.

4.3.1 Software Requirement

Below is the required software for this project:

a) Raspberry Pi OS

Raspberry Pi official operating system is Raspbian OS which is a version of Linux build specifically for the Raspberry Pi computer. All the software that needed for a basic computer function are provided in the OS, for example LibreOffice is equivalent for Microsoft Office in windows. Raspbian OS also come with web browser, email program and tools in learning programming for kids and adults.

b) OpenCV

OpenCV is an open source computer and machine learning library that mainly focus on providing computer vision application with the common infrastructure and to

increase the use of machine perception in commercial product. OpenCV make it easy for business in utilizing and modify the code as it is a BDS-license product.

4.3.2 Hardware Requirement

a) Raspberry Pi Computer

The Raspberry Pi used in this project is Raspberry Pi 4 model B. It is the latest version of Raspberry Pi lineup which is an upgrade from the previous version Raspberry PI 3 model B. It has all the needed element as a computer such as USB 3.0 port, Micro HDMI to HDMI port, wireless and Bluetooth, support dual monitor configuration and provide from 1GB RAM up to 8GB RAM option.

b) Pi Camera v1

Pi Camera is a portable light weight camera module that support Raspberry Pi computer and it communicate with the Raspberry Pi by the MIPI camera serial interface protocol. Usually, the Pi camera is used in surveillance project, image processing and machine learning because of the low camera payload.

c) Ultrasonic sensor HC-SR04

The ultrasonic sensor offers high accuracy and stable reading for non-contact range detection because it use sonar to determine distance to an object. HC-SR04 ultrasonic sensor use transmitter to send high-frequency signal. The signal then bounces back from an object that on the path. The receiver then captures the signal and calculate the distance using mathematical calculation.

4.3.3 Cost Analysis

Table 4.1: Cost analysis

No	Hardware	Price
1	Raspberry Pi Bundle:	360.00
2	Raspberry Pi Official Power Adapter	
3	Raspberry Pi 4 model B Computer	
4	Raspberry Pi Heatsink	
	Raspberry Pi Case (Black)	

	MicroSD Card	
5	Raspberry Pi Camera Module	9.00
6	Ultrasonic Sensor	5.00
7	Breadboard	16.00
	total	390.00

4.4 Detailed Design

4.4.1 Circuit Diagram

Figure 4.2 shows the circuit design for the project that consist of Raspberry Pi computer, Raspberry Pi camera, Ultrasonic sensor, 1k ohm resistor, 2k ohm resistor and a breadboard. Raspberry Pi consist of powerful feature such as the general-purpose input/output pin which called GPIO pins at the edge of the board. Most of the pins are 3V3 pins except two 5V pin and 8 ground pins which is 0V and configurable. Raspberry Pi able to control and monitor outside world by being connected to electronic circuit thanks to the GPIO pins.

HC-SR04 Ultrasonic sensor is used as a range sensor in the system. Basically, the sensor consists a transmitter and a receiver to send and capture signal. The sensor works in 5V logic and consist of four pins which is 5V supply (VCC), Trigger Pulse Input (TRIG), Echo Pulse Output (ECHO) and Ground (GND). The VCC pin are connected to a 5V pin on the Raspberry Pi board to power the module. The TRIG pins are connected to the GPIO pin (24) to send an input signal which trigger the sensor to send ultrasonic pulse which then bounced back to the receiver. The captured signal is used to measure the time between the trigger and return pulse then send a 5V signal to the ECHO pin.

From the circuit diagram, two resistors are used as a voltage divider. This is because the Ultrasonic sensor works on 5V while the input pin on Raspberry Pi works on 3.3V. It is very important to lower the voltage to avoid any damage to the hardware. Voltage divider need to have two resistors arrange in series, while the value of resistor can be varied. Figure (…) shows the schematic circuit for the voltage divider. Input

voltage is the ECHO pin from the Ultrasonic sensor which gives 5V. The nearest resistor to the input voltage is R1, and the furthers resistor to the input voltage is R2. The output voltage is between R1 and R2 which then connected to pin 23 on the Raspberry Pi GPIO.

Figure 4.1: Voltage Divider Schematic Diagram

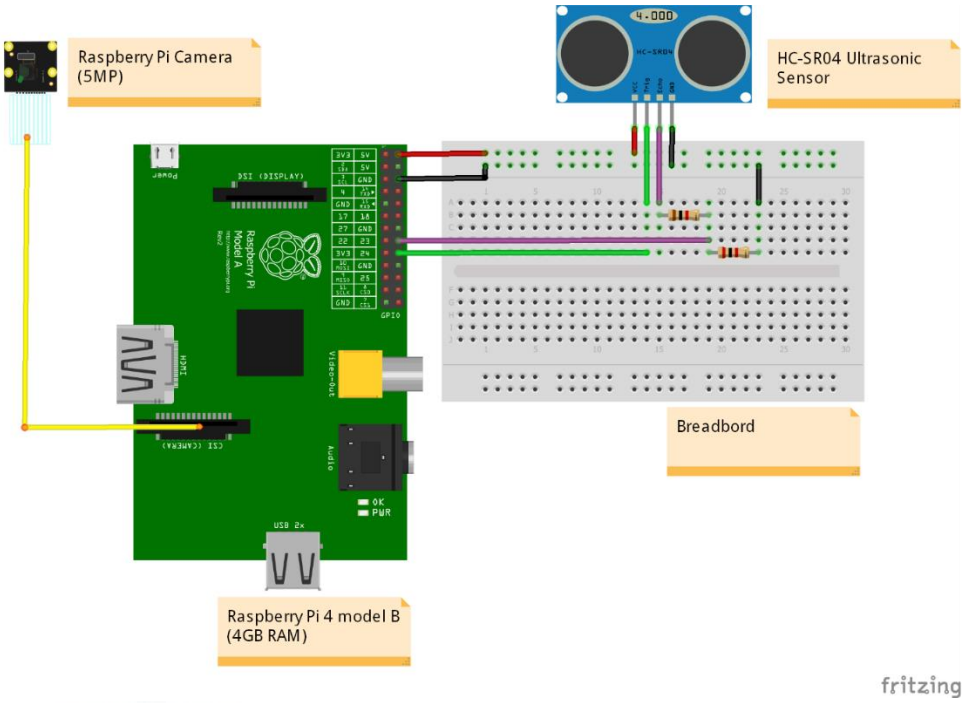


Figure 4.2: Circuit Diagram

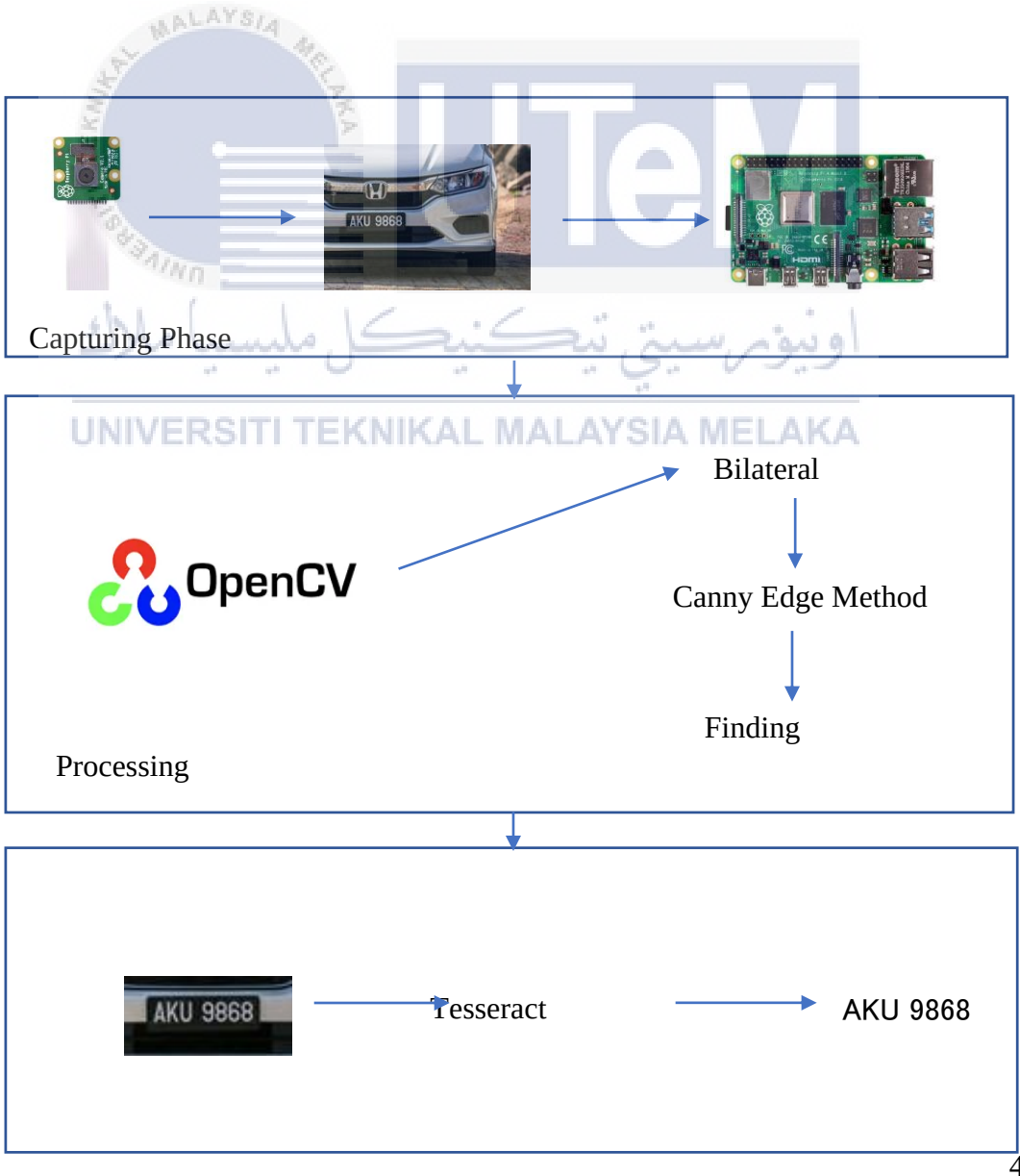
4.4.2 Architecture Design

The project consists of single unit which is used to detect, capture and process an image before comparing the result with local database. The unit consist of single board of Raspberry Pi computer, Raspberry Pi camera, and ultrasonic sensor as range sensor. The system will used plate number as an identification for vehicle to pass the gate in order to access the restricted compound area. In order to extract the plate number and convert it into something that system can understand, the system need to use a still image of the plate number, process the image and translate into meaningful format. Image capturing function will be done using a Raspberry Pi camera module that attached directly to the board using dedicated camera port.

Firstly, the system uses ultrasonic sensor to detect any present of vehicle in the capturing area. This is done by using HC-SR04 ultrasonic sensor which use high-frequency signal for distance detection. The system send signal to the sensor by TRIG pin which allows the sensor to transmit signal forward using the transmitter. The signal will bounce back if there is obstacle or object in front of the sensor. Then the receiver will capture the signal, and measure the time taken for the signal to arrive at the

receiver. The sensor then sends electrical signal through ECHO pin to the Raspberry Pi. If there is a vehicle in the range, the raspberry Pi camera will start recording.

When the vehicle arrives, the driver will push a button on the gate to initialize image capture by the Raspberry Pi camera. The camera then sends the image to the Raspberry Pi to be process. When the Image has been processed, the result is a alphanumerical character which is the vehicle plate number. The plate number then being verified by comparing the character against local database that consist of staff and lecturer's vehicle plate number. If the plate number is registered with the college, the raspberry Pi will send signal to the automated gate to open the gate arm.



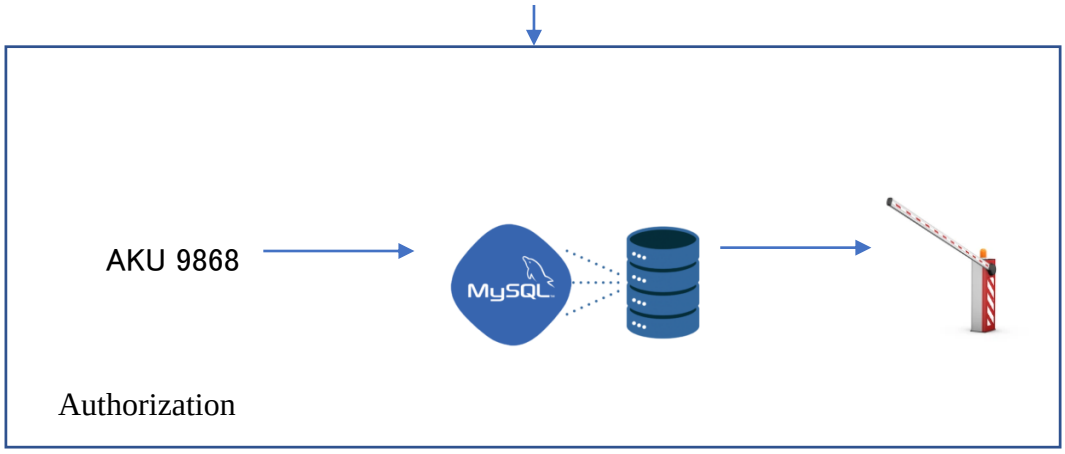


Figure 4.3: System Architecture

4.4.3 Physical Design

In figure 4.4 shows the physical design of the project that will be used in the system. Ultrasonic sensor act as range detection to detect vehicle in the capturing area and if there is a vehicle, the camera will be initialized to start recording. When the driver push the button, the camera will take the last frame as a still image and send it to the raspberry Pi. After the image being processed, raspberry Pi will send a signal to the gate to open the gate arm.

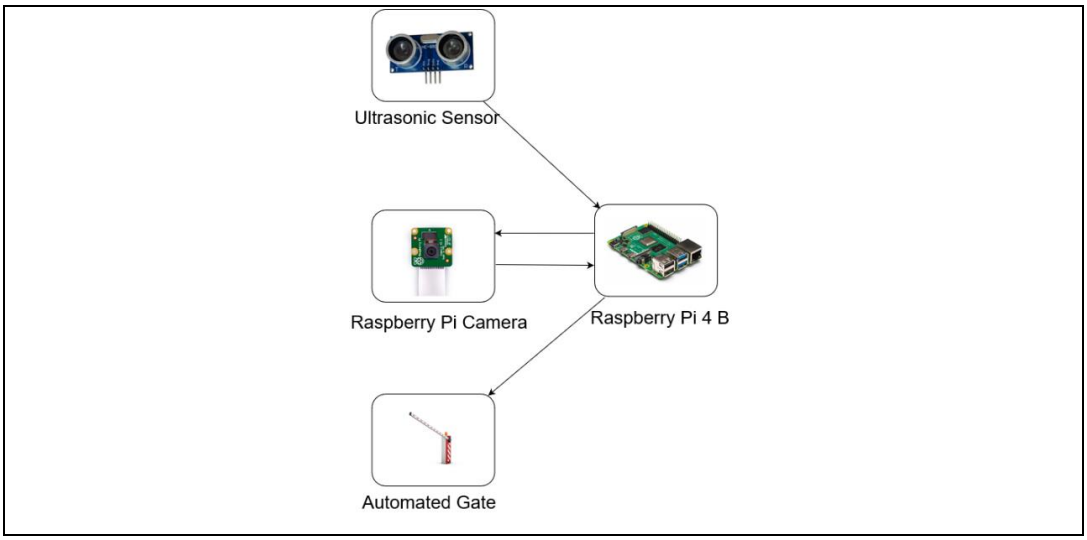


Figure 4.4: Physical Design

4.4.4 Logical Design

In this section, based on figure 4.5, it gives the view in logical design of the system where Raspbian OS running in the Raspberry Pi act as the main controller in the system. The system also running plate number extraction algorithm to identify the plate number area in an image. Then the system will use Tesseract OCR to recognize the character before checking the result with the local database.

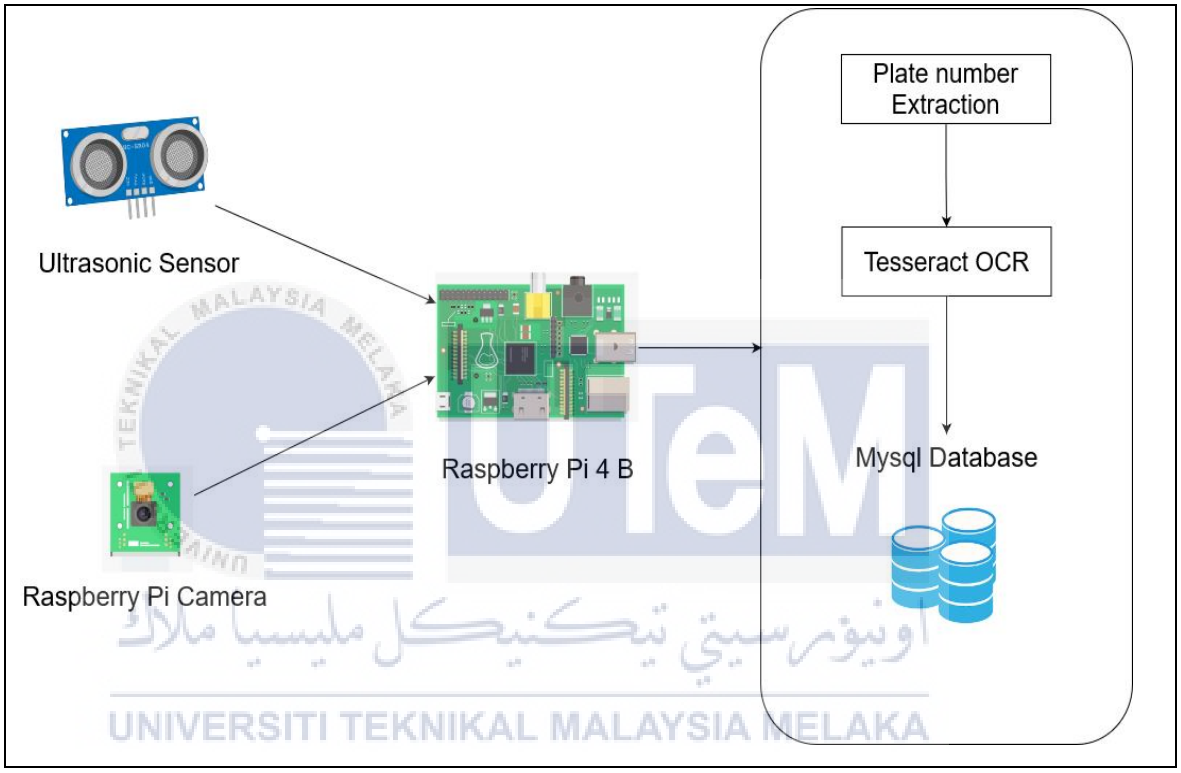


Figure 4.5: Logical Design

4.5 Flow Chart

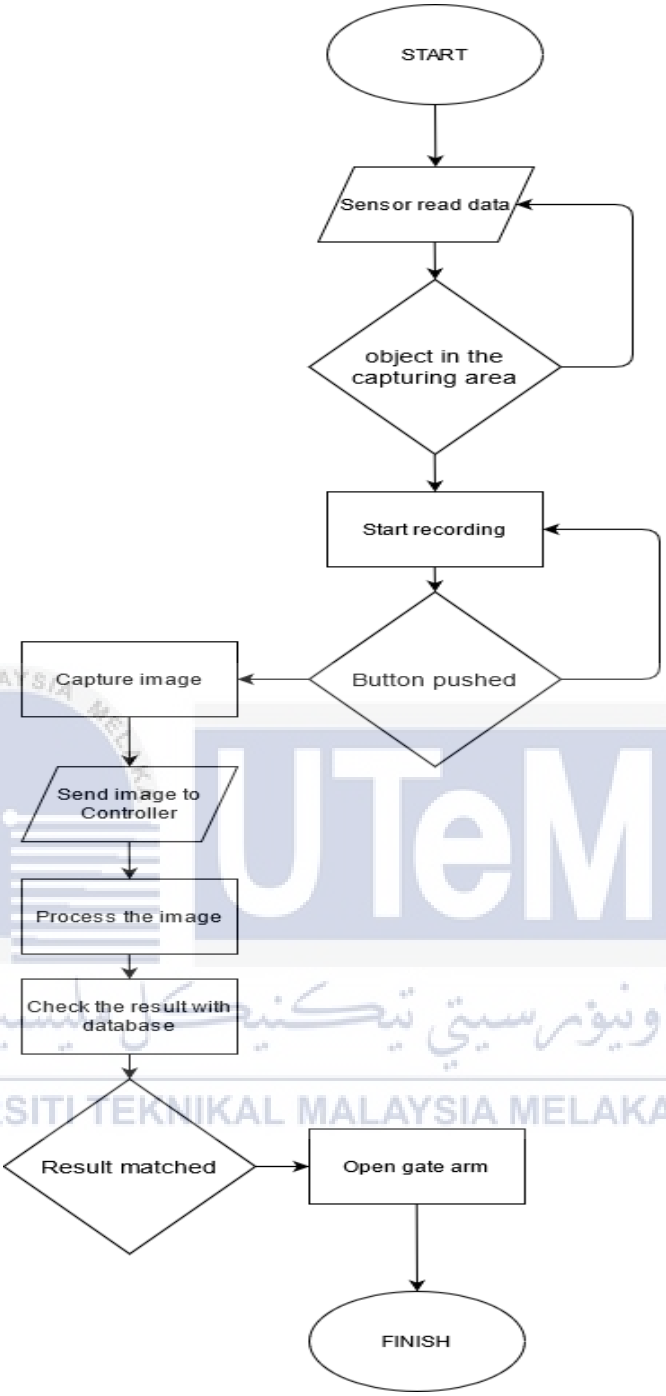


Figure 4.5.3.1: Overall system flow chart

Figure 4.5.3.1, shows the overall flow chart of the system which start with the sensor reading measurement of any object in the capturing area. When the sensor detects a vehicle, the sensor send signal to the computer to activate camera. The driver then pushes the button and the camera start to capture a still image. The image then processed and compared to the database.

Phase 1: Capturing Phase

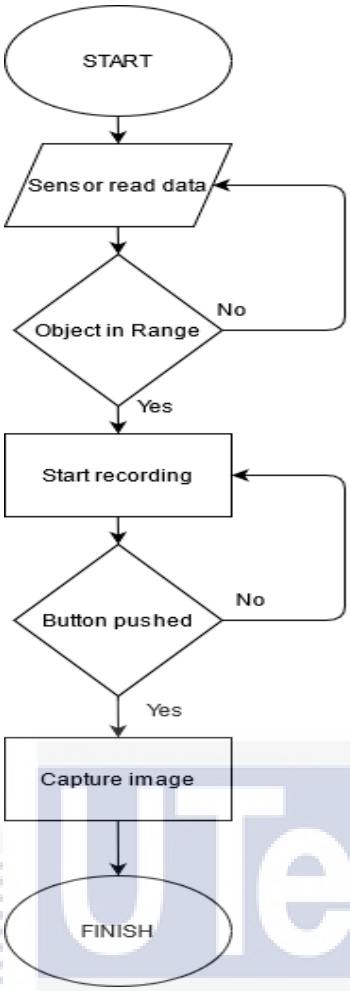


Figure 4.5.3.2: Phase 1 flow chart

In the first phase, which is capturing phase, the sensor will continually read data which is range. The sensor will send echo signal if any object enters the capturing range. The camera will start recording and wait for the driver to push the button to initialize image capturing. Then the image was sent to the computer to be processed.

Phase 2: Processing Phase

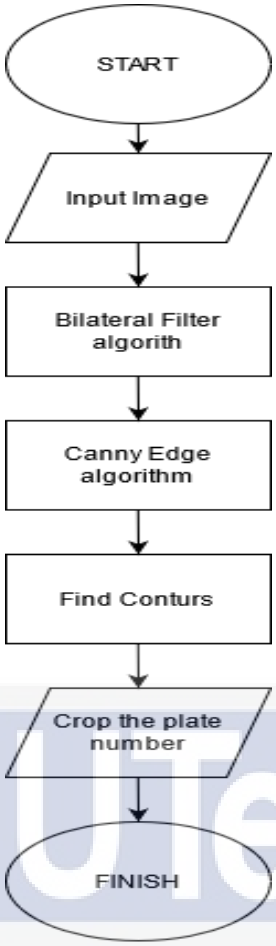


Figure 4.5.3.3: Phase two flow chart

In the second phase, the image is being processed by multiple image processing algorithm to identify the plate number in the image. Firstly, bilateral filter algorithm is used to detect the edge of the plate number. Then, canny edge method used to select the suitable candidate. Lastly find best match contours in the image. When the plate number was detected, the system crop the image and pass to the next phase.

Phase 3: Recognition Phase

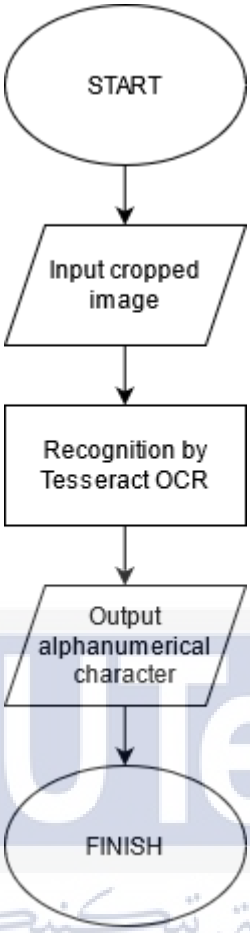


Figure 4.5.3.4: Phase three flow chart

In recognition phase, the cropped image was used to recognize the exact character using optical character recognition technique with Tesseract. Result of the process is an alphanumerical character which is the plate number of the vehicle.

Phase 4: authentication phase

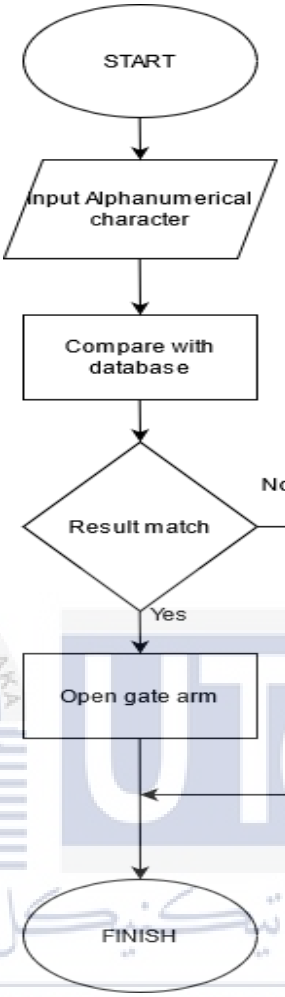


Figure 4.5.3.5: Phase four flow chart

In the authentication phase, the plate number is being checked with the local database. If the plate number match with any entries from the database, the computer will send signal to the gate to open the gate arm.

CHAPTER 5: IMPLEMENTATION

5.1 Introduction

Every steps and approaches that would be taken in the implementation phase of this project are going to be describe in details under this chapter. All the element in terms of software or hardware and the function development would also be explained such as the method that being used in the plate number extraction process, platform used to run the program and the hardware used to develop the prototype. All element that essential for the project implementation success will be explained in details.

5.2 Environment setup

Ensuring the system is functional, integration between multiple software and hardware is required. This section will define the environment setup and clarify the parameters as well as variable used in the environment setup. Besides, the hardware and software installation or configuration will be explained in this section.

Before moving to the environment setup, the Raspberry Pi 4B should able to access either using monitor or headless setup. Headless setup can be done by accessing the Raspberry Pi through SSH connection or using more convenient ways using VNC server that has been provided in the Raspberry Pi. Since the Raspberry Pi was build base on Linux architecture, it is important to make sure that the distribution is up to date.

The prototype environment consists of Raspberry Pi computer, Raspberry Pi camera, Ultrasonic sensor and LED. All the configuration for every component in the environment is configured in the Raspberry Pi using pre-installed IDE called Thorny Python. The Ultrasonic sensor and the LED will be connected to the Raspberry Pi using solderless breadboard and jumper wires. The Ultrasonic sensor used in this project need four-wire interface which are VCC in 5v, GND as ground, TRIG as trigger and ECHO as echo. Since the sensor works in 5v, it can damage the Raspberry Pi

because the Raspberry Pi works in 3.3v. The voltage from the sensor's echo pin need to be lowered by using voltage divider. The VCC pin is connected to the 5v pin in Raspberry Pi which is pin number 2 (BOARD configuration). The TRIG pin on the sensor connected to pin number 12 on the Raspberry Pi, ECHO pin was connected to pin number 18 and GND pin connected to pin number 6.

Voltage divider is a passive liner circuit that produce an output voltage that is a fraction from the input voltage. Since the Ultrasonic sensor ECHO pin use 5v, so voltage divider can be used by taking the ECHO pin as input voltage and pin number 18 on the Raspberry Pi as the output voltage. Lowering from 5v to 3.3v, 1 kilo ohm resistor can be used as resistor 1 while 2 kilo ohm resistor can be used as resistor 2, the output voltage will be estimated around 3.3v.

LED that used in the prototype are 10mm LED which has long lifetime and high durability. However, to protect from excessive voltage, 330-ohm resistor was used to protect the LED.

Pic voltage divider

```python
import RPi.GPIO as GPIO
import time

#GPIO Mode (BOARD / BCM)
GPIO.setmode(GPIO.BOARD)

#set GPIO Pins
GPIO_TRIGGER = 12
GPIO_ECHO = 24

#set GPIO direction (IN / OUT)
GPIO.setup(GPIO_TRIGGER, GPIO.OUT)
GPIO.setup(GPIO_ECHO, GPIO.IN)

def distance():
    # set Trigger to HIGH
    GPIO.output(GPIO_TRIGGER, True)

    # set Trigger after 0.01ms to LOW
    time.sleep(0.00001)
    GPIO.output(GPIO_TRIGGER, False)

    StartTime = time.time()
    StopTime = time.time()

    # save StartTime
    while GPIO.input(GPIO_ECHO) == 0:
        StartTime = time.time()

    # save time of arrival
    while GPIO.input(GPIO_ECHO) == 1:
        StopTime = time.time()

    # time difference between start and arrival
    TimeElapsed = StopTime - StartTime
    # multiply with the sonic speed (34300 cm/s)
    # and divide by 2, because there and back
    distance = (TimeElapsed * 34300) / 2

    return distance

if __name__ == '__main__':
    try:
        while True:
            dist = distance()
            print ("Measured Distance = %.1f cm" % dist)
            time.sleep(1)

        # Reset by pressing CTRL + C
    except KeyboardInterrupt:
        print("Measurement stopped by User")
        GPIO.cleanup()
```

Figure 5.1: Ultrasonic sensor program

```python
import cv2
import imutils
import numpy as np
import pytesseract
from PIL import Image
from picamera.array import PiRGBArray
from picamera import PiCamera
import smtplib

camera = PiCamera()
camera.resolution = (640, 480)
camera.framerate = 30
rawCapture = PiRGBArray(camera, size=(640,480))

for frame in camera.capture_continuous(rawCapture, format="bgr", use_video_port=True):
    image = frame.array
    cv2.imshow("Frame", image)
    key = cv2.waitKey(1) & 0xFF
    rawCapture.truncate(0)

    if key == ord("s"):
        gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
        gray = cv2.bilateralFilter(gray, 11, 17, 17)
        edged = cv2.Canny(gray, 30, 200)
        cnts = cv2.findContours(edged.copy(), cv2.RETR_TREE, cv2.CHAIN_APPROX_NONE)
        cnts = imutils.grab_contours(cnts)
        cnts = sorted(cnts, key = cv2.contourArea, reverse = True)[:10]
        screenCnt = None

        for c in cnts:
            peri = cv2.arcLength(c, True)
            approx = cv2.approxPolyDP(c, 0.018 * peri, True)
            if len(approx) == 4:
                screenCnt = approx
                break
        if screenCnt is None:
            detected = 0
            print("No contour detected")
        else:
            detected = 1
        if detected == 1:
            cv2.drawContours(image, [screenCnt], -1, (0, 255, 0), 3)
        mask = np.zeros(gray.shape, np.uint8)
        new_image = cv2.drawContours(mask, [screenCnt],0,255,-1)
        new_image = cv2.bitwise_and(image,image,mask=mask)
        (x, y) = np.where(mask == 255)
        (topx, topy) = (np.min(x), np.min(y))
        (bottomx, bottomy) = (np.max(x), np.max(y))
        Cropped = gray[topx:bottomx+1, topy:bottomy+1]
        text = pytesseract.image_to_string(Cropped, config='--psm 11')
        print("Detected Number is: ", text)
        cv2.imshow("Frame", image)
        cv2.imshow('Cropped', Cropped)
        cv2.waitKey(0)

        #addition
        break
```


Figure 5.2: Camera program and algorithm implementation with Tesseract OCR

```
if row != (0,) :
    print ("granted")
    cur.execute("insert into trafficDemo(platenumber, in_out) values('"+string+"', 'masuk')")
    print("Data Inserted Successfully !!!")
    conn.commit();
    GPIO.setmode(GPIO.BOARD)
    GPIO.setwarnings(False)
    GPIO.setup(11,GPIO.OUT)
    print ("LED on")
    GPIO.output(11,GPIO.HIGH)
    time.sleep(5)
    print ("LED off")
    GPIO.output(11,GPIO.LOW)
    cv2.destroyAllWindows()
    #GPIO.cleanup()
```

Figure 5.3: Led script with SQL statement

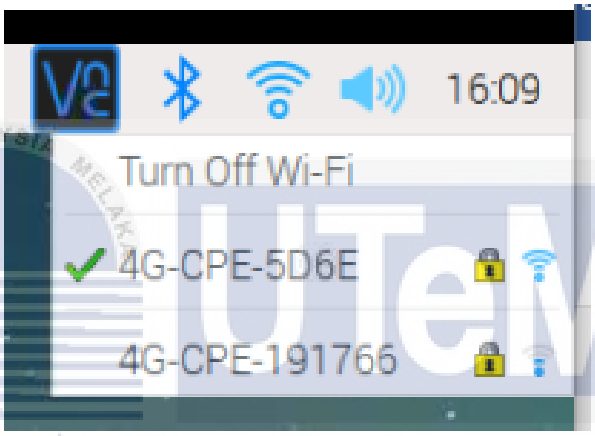


Figure 5.4: Connected to wireless network

5.3 Complete Prototype of the System

In this section, full prototype of the project will w describe which is Kolej Profesional Mara Smart Plate Number Recognition. Assembling and developing the prototype require a raspberry Pi computer, Raspberry Pi camera, Ultrasonic sensor, LED, resistor, Breadboard, jumper wire and box as the prototype casing. The prototype will connect to the college network using wireless adapter build-in on the Raspberry Pi computer. The prototype will use direct power cable to power the component.

Figure 5.5: Complete prototype of the system with ultrasonic sensor embedded on the casing

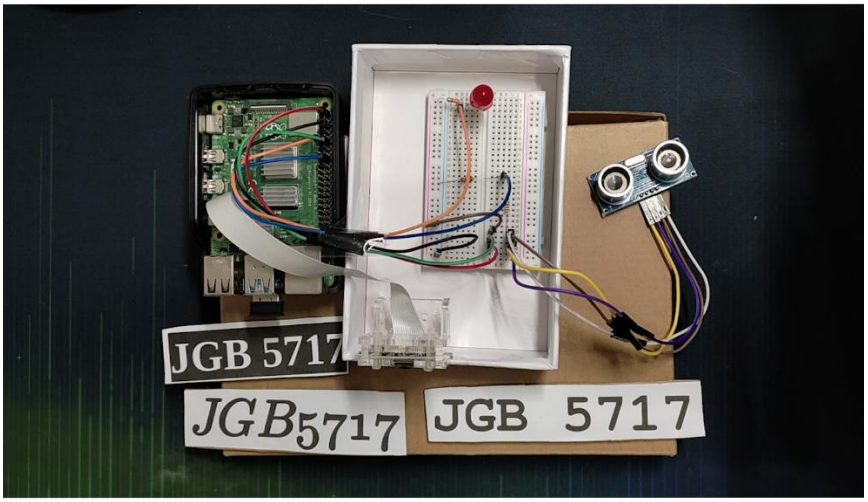


Figure 5.6: Plan view of the prototype without the ultrasonic sensor casing

5.4 Implementation Status

Implementation status explain what are the component that are being implemented through out the project. Every component take certain period of time depends on how difficult or complex the component are.

Table 5.1: Implementation status

No	Component	Description	Duration
1	Assemble the hardware	Gathering all the required hardware for the project	1-3 days
2	Building the prototype	Building the early prototype, test the early configuration, and refine based on the requirement	5-9 days
3	Configuration, installation and wireless connectivity	Installation on all dependencies and required package such as php, apache, MariaDB and more. Establish connection between prototype and local network.	7-14 days
4	Implementation of source code	Writing and programming the script that contain the main program based on requirement.	7-14 days

5.5 Conclusion

The idea of this implementation chapter is to show the processes that involves including the steps to setup the development environment for the component, sensor and device in the project. The setup show sensor connection with the main component which is Raspberry Pi computer together with other device involves. This chapter also shows how the used of algorithm is implemented to extract plate number area from a picture captured by the camera before translated by the OCR. All stages which is capturing, processing, recognition and authorization are very important to make this project a success. Next chapter, testing phase will be discussed and focused on the system testing to make sure the functionality of the project meets the requirement.

CHAPTER 6: TESTING

6.1 Introduction

In this chapter, testing phase will be conducted which is measuring, finding and inspect the quality of a product and rectify any defect that occur in the process. This process is very important in order to make sure that the product comply and follow the requirement which has been specified from previous chapter. Besides, all the necessary steps and procedure of developing testing for the project are done. The correctness of program, system logic and function will be determined by implementing the testing process.

6.2 Test Plan

Ensuring that the system working correctly is very important that is why test plan, as one of the measures need to be implemented. Numbers of testing will be conducted in the testing phase where each of the testing will be conducted by respective candidate with its role as part of developer or user. As the person that involved in the development of the entire system, thus developer will conduct all the testing regarding the system such as database. User candidate however is the one who used to conduct end user function such as recognition and plate number extraction module.

6.2.1 Test Organization

In this subsection, individual that involves during the testing process will be describe. This project will only involve two individual who are system developer and user.

i. Developer

- Developer is the person who are responsible for developing the project and expert on the system functionality. This person will decide the test case and subject that will be used in the testing in order to find error or issue in the system.

ii. User

- User is the person who test the project functionality and give feedback to the developer regarding the test. User will notify the developer of any flaws, issue or error in terms of functionality, effectiveness, stability and usability.

6.2.2 Test Environment

In this section, environment for the testing process will be describe and prepared to carry out the project. The project that will be carried out must be identified as in good condition to understand the limitation of the system. In this testing phase, the ultrasonic sensor and Raspberry Pi camera are tested in the same time as a single unit to make sure that the component are working together. The device will be tested by obstructing the sensor with object and make sure that the camera will be activated as soon as the sensor reading less than certain range.

6.2.3 Test Schedule

Every testing activity are conducted based on the completion of each module on the prototype that being developed by the developer. Early version of the prototype will be develop and tested before being rectified back to add new features and fix current issue. All the test details were list in the table below including the module and feature in the system

Table 6.1: Prototype testing

Prototype	Test case	Duration
Version 1	Connectivity capturing	1-3 days
Version 2	Connectivity Capturing processing	1-5 days
Version 3	Connectivity	1-7 days

	Capturing Processing Recognition Authorization	

6.3 Test Strategy

There are many testing strategies can be used in the testing phase. In this project, black box technique will be used to test the functionality of the project. Basically, to focus on the input and output of the project without referring the code structure or implementation details of the software, black box testing technique is suitable to be used in this testing phase.

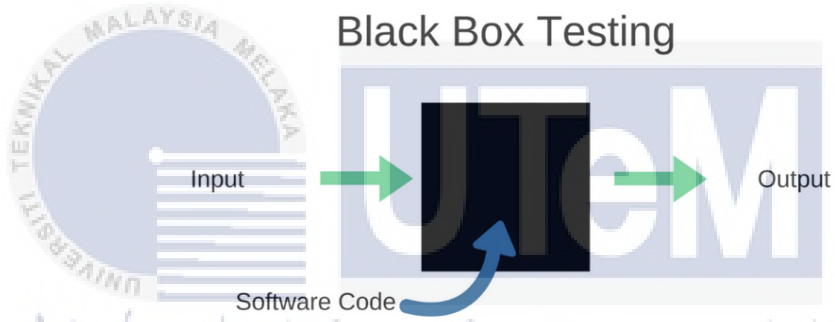


Figure 6.1: Black Box testing strategy

In addition, black box testing can be varied such as functional testing, non-functional testing, regression testing and others. However, the testing that will be used in this project is functional testing which is used to test the project functionality. Functional requirement of the system that being developed by the developer are the main focus of this testing technique and this testing to make sure that the controller used, sensor and device in the project are communicating properly. The testing involves reading of the ranges from ultrasonic sensor and the activity of the Pi camera.

6.4 Test Design

In this part of the project, this section explains the test case of the project and what are the expected result for the certain situation chosen. The test description is shown in the table below.

Table 6.2: connectivity test

Test Case	Connectivity
Test Functionality	• Test the connectivity of the Raspberry Pi with computer using VNC viewer
Precondition	• The Raspberry Pi connected with the same wireless network as the computer • Identify the Raspberry Pi IP address • Identify the username and password use in the Raspberry Pi • The VNC server in Raspberry Pi enabled for connection
Execution Step	• Power on the Raspberry Pi and the computer to access the VNC. • Connect both Raspberry Pi and Computer to same network • Use raspberry Pi IP address to connect
Expected Result	• The VNC viewer able to connect to the Raspberry Pi
Error Message	None
Result	Passed

Table below show the testing design for capturing module implemented in the project using python code to make sure all device used can be controlled by the Raspberry Pi.

Table 6.3: capturing test

Test Case	Capturing module
Test Functionality	• Test the connectivity of Ultrasonic sensor and raspberry Pi camera with the Raspberry Pi.
Precondition	• Raspberry Pi accessed by VNC viewer • The sensor and camera are setup
Execution Step	• Connect the ultrasonic sensor and the camera with Raspberry Pi • Run the program that contain function to measure range and activate camera using the IDE

	• Use object to block the sensor
Expected Result	• The shell in the IDE display the reading from the sensor • The sensor reads distance to object in front of it • The camera start recording as soon as the sensor reads ranges below certain value.
Error Message	None
Result	Passed

Table below show the testing for processing module to make sure all the algorithm used in the program are working as expected.

Table 6.4: processing test

Test Case	Processing module
Test Functionality	• Test the processing module that need to extract plate number from an image
Precondition	• Establish the program in the raspberry Pi
Execution Step	• Run the program • Block the sensor • Wait for the camera to capture image
Expected Result	• Green box appears around the plate number
Error Message	None
Result	Passed

Table below show recognition module testing. This testing was expected to have accurate reading on the character in the plate number area that being capture from previous stage process which is processing stage.

Table 6.5: recognition test

Test Case	Recognition module
Test Functionality	• Test the recognition function used in the project which is tesseract OCR
Precondition	• Establish the program in the raspberry Pi
Execution Step	• Run the program • Block the sensor • Wait for the camera to capture image

	• Observed the shell in the Raspberry Pi which will output the plate recognized by the system
Expected Result	• The system able to recognize the plate number
Error Message	None
Result	Passed

Table below show testing for authorization module which need the database connection and sql script to compare the plate number with the data in the local database that has been set up earlier.

Table 6.6: Authorization test

Test Case	Authorization module
Test Functionality	• Test the program that should able to compare the plate number with data from database
Precondition	• Establish the program in the raspberry Pi • Prepare the database with registered plate number
Execution Step	• Run the program • Block the sensor • Wait for the camera to capture image • Observed the shell in the Raspberry Pi which will output the plate recognized by the system
Expected Result	• The LED will light up as the plate number is a registered plate number
Error Message	None
Result	Passed

6.5 Data and Analysis

To make sure the Raspberry Pi is already connected to the network, VNC viewer software should be able to connect to the Pi and control the Pi remotely.

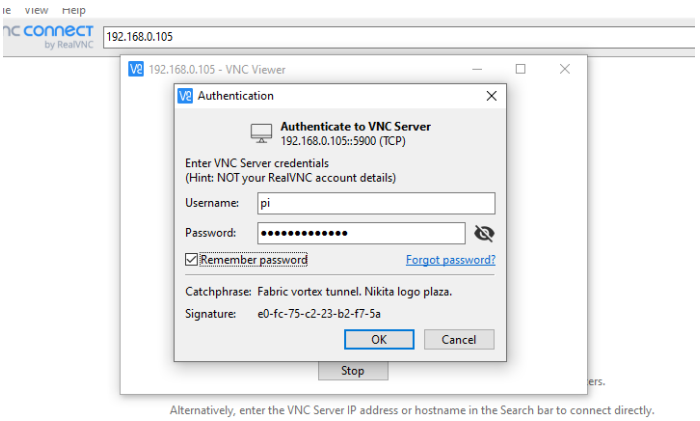


Figure 6.2: Connection between VNC viewer and the Raspberry Pi is established and the VNC requesting a usersname and password

Figure 6.3: The VNC viewer successfully connect to Raspberry Pi.

Testing the capturing module to make sure that the sensor are reading measurement correctly and the camera are automatically activated when there are object in the capturing range

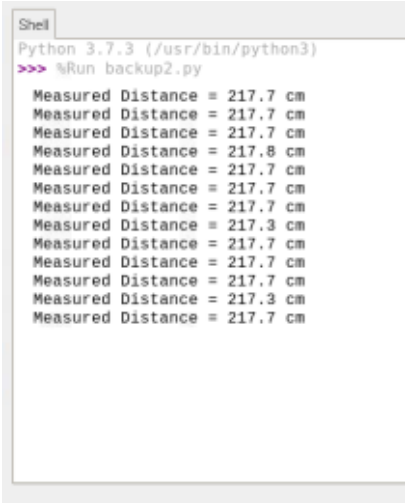


Figure 6.4: The shell read measurement as expected

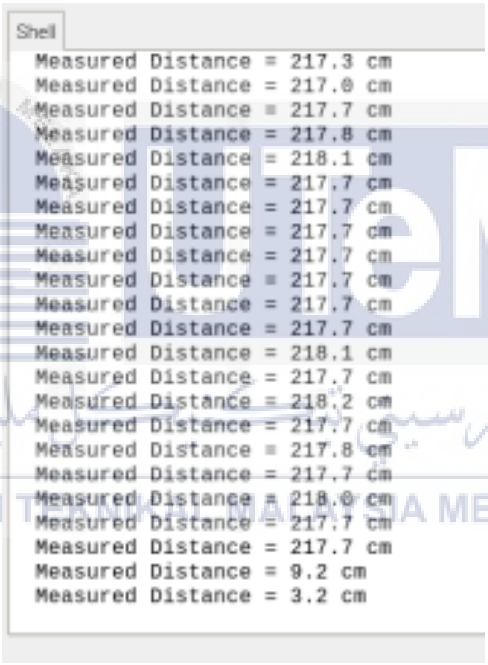


Figure 6.5: An object is put in front of the sensor thus the reading changes.

Figure 6.6: Once the reading is less than 5cm, the camera is automatically activated to start recording.

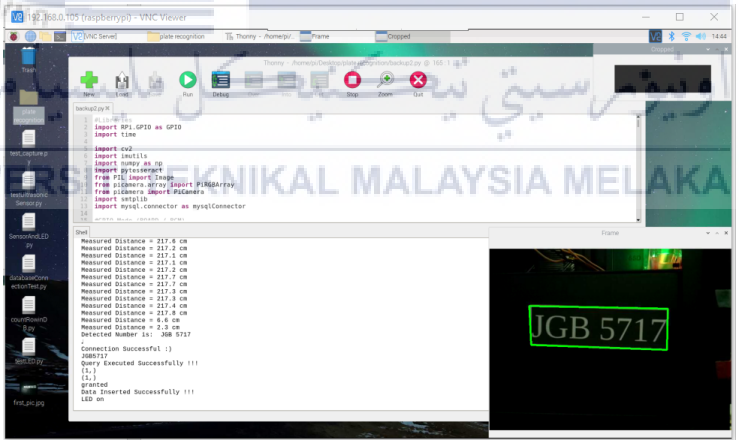


Figure 6.7: The camera uses the last frame as a picture and the system process the picture to detect plate number area.

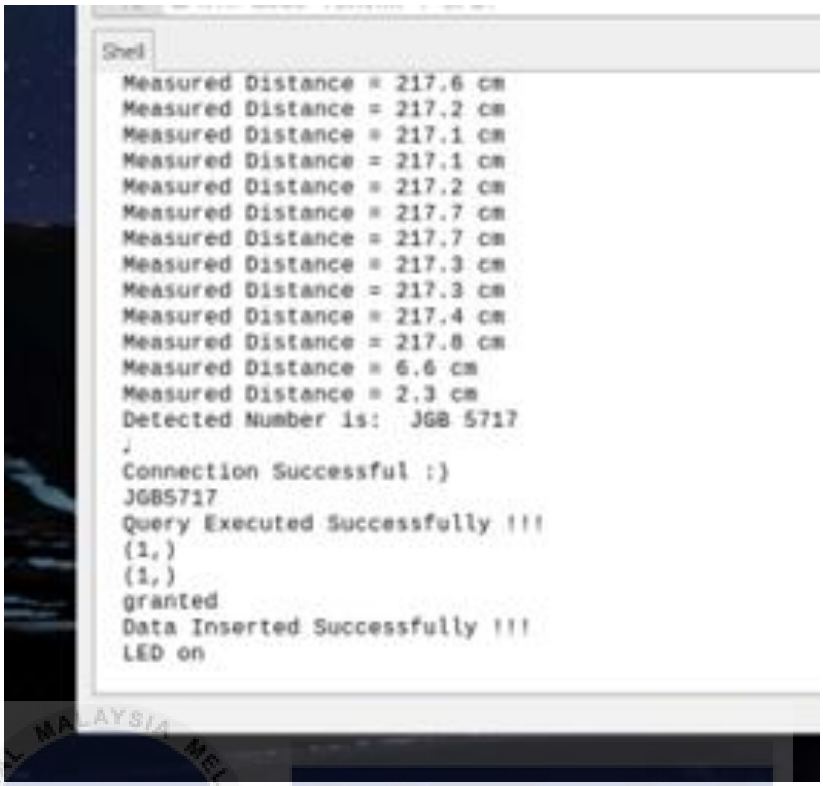


Figure 6.8: The detected plate number is accurate which is JGB 5717

TC 5

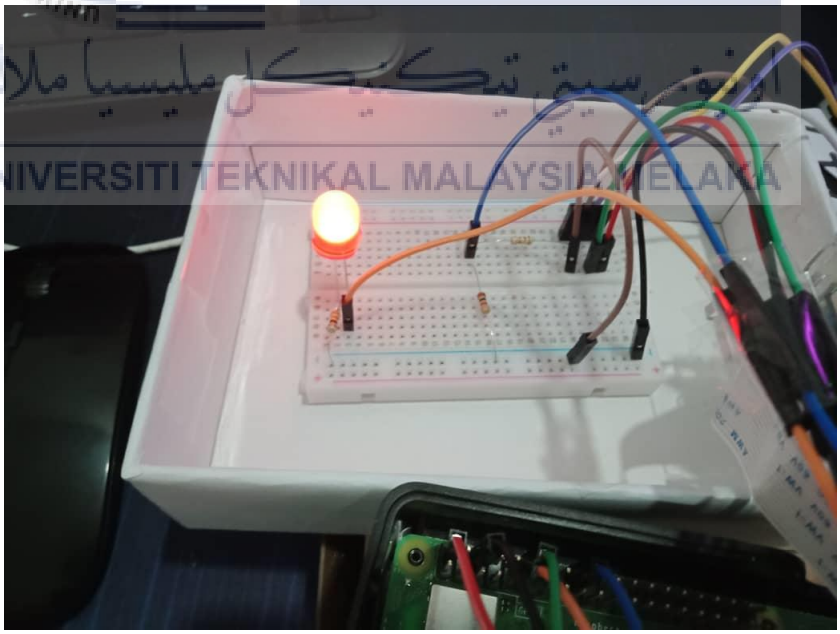


Figure 6.9: The led turn on in few second indicate the plate number are registered plate number as in the database.

6.6 Summary of Analysis

Overall system test that are involves in this project will be review in this section. All the information gathered from every version of the prototype will contribute in maximizing the accuracy and efficiency of the system. In order to make sure the system have consistent reading, multiple plate number with different font and background colour is tested. Figures below show result from different plate number type tested and their result.

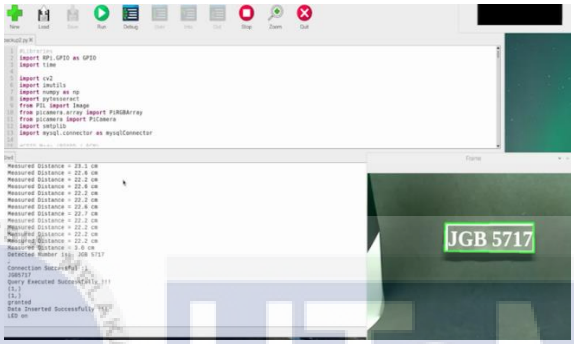


Figure 6.10: White plate number with black background

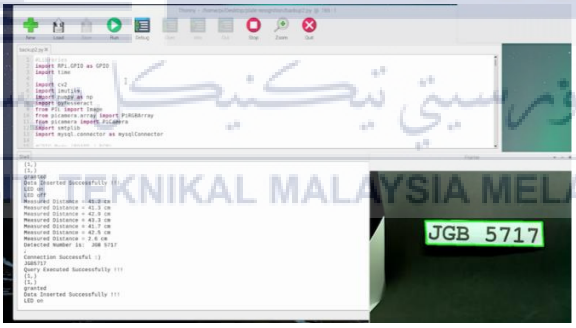


Figure 6.11: Black plate number with white background

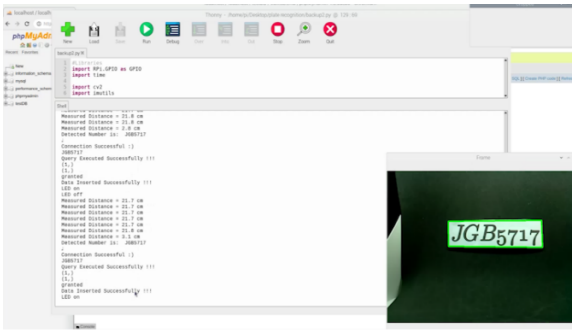


Figure 6.12: black plate number with italic and different alignment of the alphabet and number.

Figure 6.7: Result of the test on multiple plate number with different types

Font colour / styles	Background colour	Contour	LED
white / standard	Black	detected	On
Black / non-standard	White	detected	On
Black / tilted	white	detected	On

6.7 Conclusion

The functionality and the test analysis result are described in this chapter. Different element that make up the prototype also being shown in this chapter to give clear understanding on how the system works in real life. Different types of plate number are being test to investigate the accuracy of used algorithm in this project. The next chapter will explain the conclusion of the project.

CHAPTER 7: CONCLUSION

7.1 Introduction

In this part of the report will discuss about the summary of the project by reviewing the objectives which have been explained previous chapter. In addition, this section also will explain how the project's objective is achieved in this project.

7.2 Project Summarization

The first objective is to investigate the current parking slot automated gate system which is used in Kolej Professional Mara Indera Mahkota. Through the research, the project has identified various weaknesses in the system that can be improve. The aspect that can be improve such as security which the current system lacking. The proposed system also offers real time data update on the vehicle that pass through the gate.

The second objective to provide controlled and manageable traffic flow in the restricted area as they have limited space and can hold certain amount of vehicle in a

time. As been discussed in previous implementation and testing phase of the project, the project has developed a unique authorization system that translate picture to character. The system uses range sensor to detect vehicle and camera to capture image and will process the image on the spot to make future decision.

The last objective is to develop a plate number recognition system as identification instead of using access card. This project provides more convenient ways to give access or deny access to the restricted area. Since the access card method are easy to bypass and manipulate, the project provides more secure and complex method in giving access.

7.2.1 Strength and Weakness

Every project has their own strength and weaknesses and this project is no exception. In this section will discuss about the project strength and weaknesses. Even though this project brings very useful feature but also prone to other flaws and weakness.

Table 7.1: Strength and weaknesses

Strength	Weakness
• Eliminate the traditional system that use access card • Provide simplicity to the system • More secure compared to previous system used • Provide log of traffic pass through the gate	• Surrounding light effect the picture quality • Hardware degradation

7.3 Project Contribution

This section of this project will detail out the project contribution to the target user and others. The project actually offers manage and control the use of vehicle by student in the restricted are inside the college compound. Even though the college currently use access gate which need an access card to get pass through, however the current gate system is not reliable because student still able to get pass through using many tactics and way to get over the gate such as duplicating the access card. In addition, this project really contributes to reduce number of vehicle and traffic used in the restricted. Based on the previous chapter that already being discussed, the college have really limited parking area and small space around the administration area. Since all the parking area are limited to the lecturer and staff, any additional vehicle in the area will rise some problems. The road in the area also small and can be dangerous if there is to much vehicle moving in the area. Besides, this project provides smart and effective ways to authenticate user through the access gate. Using the plate number recognition, student not able to bypass the access gate and reducing the traffic in the restricted area.

7.4 Project Limitation

Limitation is any form of restriction that effect in any way to the project functionality. In this section, project limitation will be discussed to identify the project limitation which can diminish the project goals. The one of the project limitations is to maintain and make sure the accuracy of the algorithm to detect and extract plate number area from the capture images. The algorithm really needs a good capture of the plate number to be able to find the plate number area. Since there is so many variables that can affect picture quality such as lighting, the reading could be less accurate over time.

The next limitation is to make sure ultrasonic sensor read accurate reading in detecting vehicle in the capturing area. Since the system consist of sensor, the sensor can be less accurate over time when it is being used regularly. Since it may be less accurate, the system needs a regular maintenance to make sure sensor and device have highest accuracy possible.

7.5 Future Works

The future improvement that can be made on the project is the algorithm effectiveness and accuracy in detecting the area of the plate number in the captured picture. There are a lot of technique that can be added to the algorithm to increase the accuracy in extracting the plate number area. The system also can be improved by adding more details in the authorization such as detecting the plate number and the colour of the car to match before giving access. In that way, the system even more secure and complex thus student do not have any way to bypass the system. In addition, the system can be improved and expand by implementing notification to the staff and lecturer every time they pass through the access gate. This can be crucial as if any student try to used their plate number, they can be notified early.

7.6 Conclusion

As the conclusion, all the objective mentioned before for this project has been achieve successfully where the system is able to capture a plate number and translate it before compare with the database to give access to the user. The system successfully implemented and presented using real prototype where the ultrasonic sensor able to detect object in the capturing range and the system trigged the camera to start recording before translate the picture to text. This project provide great values compared to the current gate system used. This project provide more simple, effective and secure way to give access to lecturer and staff into the compound.

(Agrawal and Singhal 2015)

(Balon and Simic 2019)

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