

**CAR LICENSE PLATE NUMBER RECOGNITION USING MEDIAN
FILTERING, FREQUENCY DOMAIN FILTERING AND
MORPHOLOGICAL FILTERING**

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN

JUDUL: CAR LICENSE PLATE NUMBER RECOGNITION USING MEDIAN FILTERING, FREQUENCY DOMAIN FILTERING AND MORPHOLOGICAL FILTERING

SESI PENGAJIAN: 2020 / 2021

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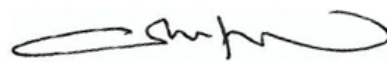
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CAR LICENSE PLATE NUMBER RECOGNITION USING MORPHOLOGICAL
FILTERING, FREQUENCY DOMAIN FILTERING AND IMAGE FILTERING
TECHNIQUES

AISYAH BINTI MOHAMAD HAFIZUL



این رپورٹ سبھی تکنیکل ماسیسا ملائکہ
This report is submitted in partial fulfilment of the requirements for the
Bachelor of Computer Science (Computer Security) with Honours.

FACULTY OF INFORMATION TECHNOLOGY AND COMMUNICATION
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DEDICATION

I dedicated this project for my mother who single handedly taking care of three daughters. My beloved sisters and my grandparents.

To my friend Nurul Aiman Asyiqin Binti Nor Azrin

To my close friend Fehed Wasti

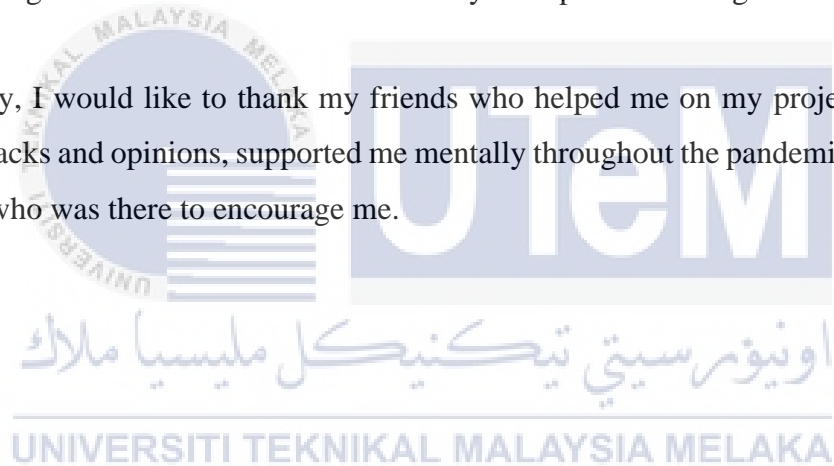


ACKNOWLEDGEMENT

Fistly, I would like to thank Allah S.W.T for blessing me with additional knowledge and giving me guidance and strength to proceed with my final year project. I would like to thank my supervisor, Dr Othman Mohd, who has helped me through all aspects of the project whether it be relating to the final implementation of the analysis or academic writing as well as helping me get through the struggles faced during the pandemic throughout my final year project at UTeM.

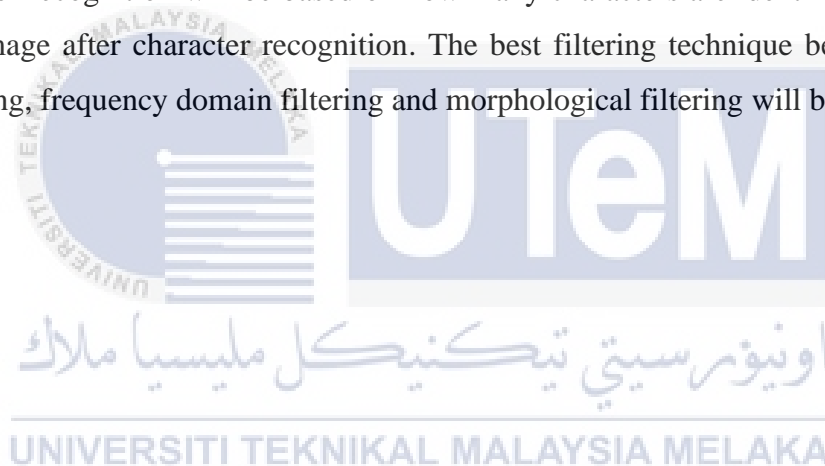
Furthermore, I'd like to thank my mother for endless support, giving me motivation to continue with my final year project and reassure me when I am feeling like giving up. Teaching me the basics needed in a final year report and being the backbone of my life.

Finally, I would like to thank my friends who helped me on my project. Giving me feedbacks and opinions, supported me mentally throughout the pandemic, in particular F.W who was there to encourage me.



ABSTRACT

The project focused on the recognising the plate numbers image using MATLAB platform. The image will undergo few images processing for a better read on the image characters. The images used are in various kinds of condition. There are several techniques will be applied as a filtering technique such as median filter, frequency domain filter and morphological filtering. Image will then be converted into binary image, the value will be based on 1s and 0s or black and white only. Afterwards, the image will undergo edge-detection to detect the plate number's characters location and then characters found will be segmented. Finally, the recognition step is done using template matching technique which the characters will be scanned using the template and the most matching pattern will be identified. The result of the plate number recognition will be based on how many characters are identified correctly in the image after character recognition. The best filtering technique between median filtering, frequency domain filtering and morphological filtering will be chosen.



ABSTRAK

Projek ini memfokuskan pada mengenali gambar nombor plat menggunakan platform MATLAB. Imej akan dijalani beberapa pemprosesan gambar untuk membaca abjad gambar dengan lebih baik. Gambar yang digunakan akan berada dalam pelbagai jenis keadaan. Terdapat beberapa teknik yang akan diterapkan sebagai teknik penyaringan seperti *median filter*, *frekuensi domain filter* dan *morphological filtering*. Imej kemudian akan ditukar menjadi gambar binary, nilai gambar akan berdasarkan hanya 1 dan 0 atau hitam dan putih. Selepas itu, gambar akan menjalani pengesanan tepi untuk mengesan lokasi abjad nombor plat dan kemudian lokasi yang dijumpai akan disegmentasikan. Akhirnya, langkah pengecaman dilakukan dengan menggunakan teknik pencocokan templat yang mana abjad akan diimbis menggunakan templat dan corak yang paling sesuai akan dikenal pasti. Hasil pengecaman nombor plat akan didasarkan pada berapa banyak watak yang dikenal pasti dengan betul dalam gambar selepas pengecaman watak. Teknik penapisan terbaik antara penapisan median, penapisan domain frekuensi dan penapisan morfologi akan dipilih.

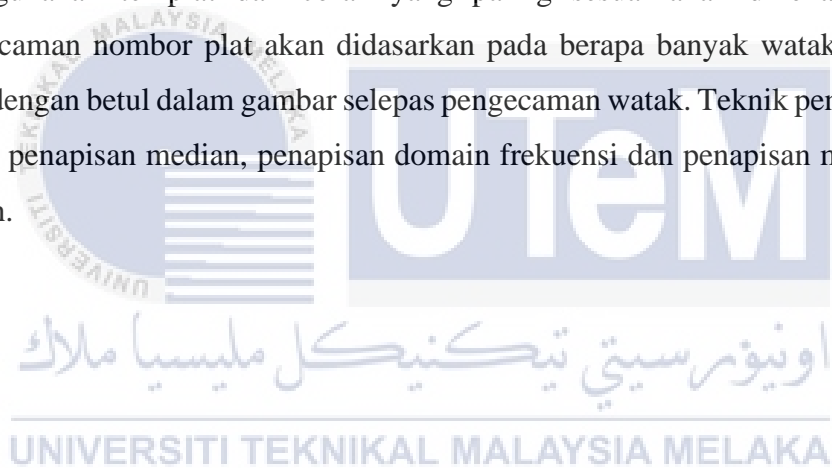


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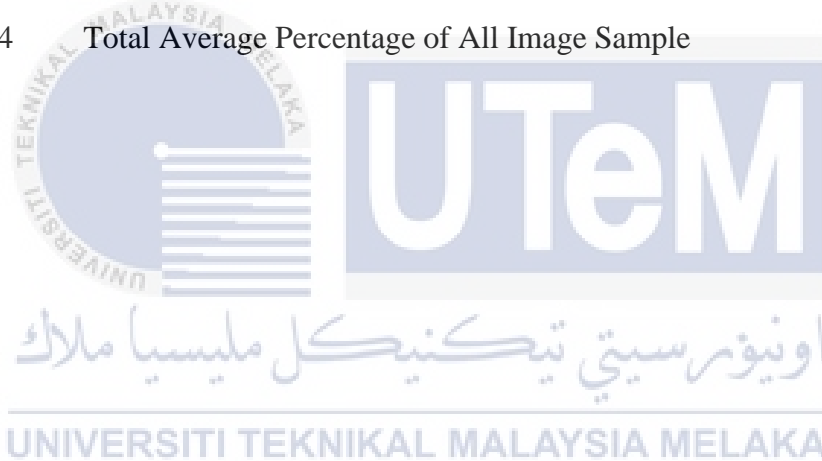
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CHAPTER 1

INTRODUCTION

1.1 Introduction

Car license plate number recognition is a project to identify vehicles' their plate number in MATLAB. Plate number recognition is a technology with pattern recognition technology that collects a type of plate number and compare it with to predefined collection of samples in a file. The deliverable of this is the comparison between the actual plate number and the predefined samples. The issues of plate number recognition are the human error and behaviour such as maintenance of the plate number. Low resolution of plate number image and non-uniform plate number model. Techniques used for this project is based on MATLAB only and there are various techniques has been used to recognize the characters of the images.

1.2 Problem Statement

The problem statement of the project is the quality of the image is low or it is too small to be able to recognize the characters. Next, the vehicle's plate number has gone through poor maintenance, the characters are damaged by natural disaster. The summary of the project statement is as in Table 1.1.

Table 1.1 Summary of problem statement

PS	Problem Statement
PS ₁	Difficulties on recognising the plate numbers that is in certain damaged condition or has small images

1.3 Project Question (PQ)

Based on the problem statement discussed in 1.2, there are some questions arises from it. The summary of the project question as shown in Table 1.2.

Table 1.2 Summary of Project Question

PS	PQ	Project Question
PS ₁	PQ ₁	What are the three techniques to improve readability of the plate numbers?
		Which of the techniques has the best output of the plate number recognition based on the three techniques?

1.4 Project Objective

Based on the problem statement and project question discussed above, the objectives of this project were summarized and as shown in Table 1.3.

Table 1.3 Summary of Project Objectives

PS	PQ	PO	Project Objective
PS ₁	PQ ₁	PO ₁	To identify the techniques of plate number recognition
		PO ₂	To implement three techniques of plate number recognition using morphological filtering, frequency domain filtering and image filtering techniques.
	PQ ₂	PO ₃	To evaluate the best techniques of the plate number recognition based on those three techniques

1.5 Project Scope

In this project, the simulation will be conducted using MATLAB. There are Python that has in-built library, but MATLAB has it better with matrix computations. Also, some of the MATLAB toolboxes is inequivalent to the Python libraries. Still images of the plate numbers from various situation will be used such as unmaintained plate numbers, small images to help deduce the better technique. The image will undergo three different technique of image processing that is median filtering, frequency domain filtering and morphological filtering. After removing unwanted details in the image, all numbers and alphabets will be segmented by using bounding box method. Afterwards, template matching approach is used to recognize the numbers and characters.

1.6 Project Contribution (PC)

This project beneficial for other recognition process such as fingerprint, facial recognition that can be used for security purposes. The project provides three different techniques that can be applied for image processing, one of those three could be used for further applications.

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Table 1.4 Summary of Project Contribution

PS	PQ	PO	PC	Project Contribution
PS ₁	PQ ₁	PO ₁	PC ₁	Classify the methods that can be used for image filtering
		PO ₂	PC ₂	Proposed the general way of the three images filtering technique
	PQ ₂	PO ₃	PC ₃	Identify the best technique to recognize the plate numbers

1.7 Report Organisation

Report organisation contains the outline of the chapters of the final year project report. Chapter 1 of this report discussed the overall summary of this project, including the problem statement, project questions, project objectives, the scope of the project, how the project can contribute and the organization of this report.

In Chapter 2 is the literature review where it encapsulates the recent research and scholarly sources relevant on the topic and theory in this project. This chapter also summarizes the particular of theory on simulation approach that connected with this project.

In Chapter 3 is the methodology part which summarize about the method that will be used in this project to obtain the result. In this project the method that will be used in recognizing the license plate character is image processing approach using different image filtering techniques simulation using MATLAB.

Chapter 4 explains the results of the analysis of the beginning of design and the result of detailed design. The result is represented in the form of performance table, the network simulation result from the network training and the discussion on recognition result.

Chapter 5 explains the implementation of the project. The techniques used are listed and explained.

Chapter 6 describe the activity involved in the implementation phase during the simulation/testbed project. It has critical analysis on the results.

Chapter 7 consist of the overall summary of the project, what contribution that has been made in this project, the limitation found when conducting the project and future works that consist of suggestions from the limitation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the related work of this project was discussed and similar project that has been conducted by previous researchers. This project mainly focused on analysing which image processing is better for recognition of the plate numbers. Therefore, localization of the car plate is not included. Based on that, reviewed the current problem faced by previous work and proposed solution of the problem.

2.2 Related Work

Since the 1960s, image processing has been used to increase the quality of individual images. MacDonald (2013), stated that, image processing is a necessary step since human eye does not perceive images in the same way that digital imaging technologies do. Meanwhile, image pre-processing was more concerned with preparing images for efficient use. Filtering, colour transformation, brightness correction, and other image pre-processing techniques are examples. It is possible to achieve good image quality by processing the data (images).

Image processing filtering is used to suppress either the high frequencies (low-pass filtering) in the image which leads to smoothing of the image or the low frequencies (high-pass filtering) that is for sharpening of the images. The image can be filtered in both frequency domain and in spatial domain. When smoothen or blurred filter are applied, it will eliminate noises which is an unwanted information of image that complicates the desired information. Gonzalez R. C. et al (2020), stated that, this technique of filtering is called linear filtering where they used a Fourier multiplication. Linear operations multiply each pixel in the neighbourhood by corresponding coefficient and summing the results to obtain the response at each point.

As for nonlinear filtering, they also based on neighbourhood operations where they slide the centre point through an image are the same. However, rather than

computing sum of products as linear operations, nonlinear let the response at each centre point be equal to the maximum pixel value in its neighbourhood. Balafar M. (2012), although linear filters tend to be simple in concept, they degrade image details and edges of the image. Padzil F. M. (2016), nonlinear filter simply replaces each pixel with the middle value which makes it help preserving edges.

There is another technique can be used as filtering called morphological filtering. The main morphological operations are called dilation and erosion. Raid A. M. et al. (2014), for dilation operation, the objects are expanded making the small holes filled and objects to be connected. Meanwhile, for erosion operation, the objects are diminished with etching away their boundaries.

Image segmentation is the part where the object in the image is separated into parts or regions. There are two different techniques that co-exist for it, region-based segmentation, and edge detection segmentation. As for region-based algorithm, it separates the objects into different regions based on some threshold value. Edge detections algorithm, focus more on discontinuation local features of an image.

2.3 Critical review of current problem and justification

There are various solutions of relevant problem. The main issues in plate number recognition are climate condition, environmental interference, the maintenance of the car plate and accuracy of number plate localization.

A similar project done where they focused on Malaysia's plate numbers using a horizontal density vector method to locate the plate numbers (Omran Khalifa et al, 2007). Due varieties of number characters and some old plate number designed as a square shape with the characters written in two lines. The plate extraction process that is successfully located the plate numbers are 92.1%. This technique of locating the plate numbers is good for detecting plate numbers from different angles and distances. However, the general error during this process is due to bad quality of input image. By applying a useful pre-processing technique to enhance the image quality mitigate the errors based on the condition of the image.

One of the techniques conducted by Ragini Bhat and Bijender Mehandar (2014), where they used the morphological operations on the images and Sobel edge detection following by template matching for character recognition. However, this

technique could not recognize the unmaintained car plates, blurry images, and low resolution of the characters. It may be due to pre-processing phase which is not thorough for these situations of images.

An automatic vehicle number plate recognition system proposed by using structured elements. After undergoing pre-processing techniques, they used canny detection algorithm to detect the edges of the plate number and morphological operation applied to remove unnecessary objects in the image. After acquiring the desired plate number, the image segmentation is applied to separate the characters. By selecting correct threshold values, the characters are enhanced therefore only the alpha-numeric characters in the image is shown. With vertical blank areas between two different characters are used to separate them, each row and column data are stored. Characters are compared by the similarity of object or element. The proposed technique has the recognition rate of 92% for 150 different plate number images. Some failures are said to be the cause of abnormal size of the number plate or image of the car is too far (Islam et al, 2015).

R.Radha and C.P.Sumathi (2012), conducted a research for number plates written with contrast background and foreground. The extracted objects obtained after going through pre-processing step that requires the image to be converted into grey scale, they include median filtering to remove unwanted noise. All the objects are drawn bounding boxes around them and only characters in the connected objects are extracted. The test was conducted on 100 images and 95% of the images' number plates localized properly and 5% of it are rejected due to damages in the number plates.

Sarbjit Kaur and Sukhvir Kaur (2014) developed an efficient approach for number plate extraction. The approach that is used is noise removal by iterative bilateral filter, which is a nonlinear filter, contrast enhancement by using adaptive histogram equalization and morphological opening and image subtraction operation. The plate number then is enhanced by morphological dilation, erosion, and opening and closing operation. The extraction process of plate numbers is said to work well for low resolution, noisy and low contrast images with the success rate of 97.14%.

Enhancement can be made for the median filter. In a survey, there are several approaches on how to manipulate the median filtering method (George Ginu et al, 2018). The comparison study showed that threshold median filter is the better method for removal of noise from images. As the process only the noisy pixel thus helps to retain the features and edge of an image.

In addition, we have morphological filtering that is frequently used in plate number recognition system by the researchers. The dilation and erosion able to eliminate unnecessary detail in the image meanwhile opening and closing act as a noise filter that comes afterwards to reconnect the lines that has been separated by dilation and erosion operation. Another operation that can be used for shape detection is the hit-or-miss transformation. Morphological filtering can be applied to manipulate grey-scale such as smoothing, gradient, top-hat transformation, and textural segmentation. Morphological considered a powerful tool for extracting features of interest in an image (Srisombut, 2004).

There are other techniques that can be applied as a filter rather than just median filter and morphological filter. Frequency domain is another technique of filtering for image processing. Fast Fourier Transform developed by Jean Baptiste Joseph Fourier played an influential role in image processing. It consists of lowpass and high pass filter that can act as both noise-removal and edge preservation process, respectively (Makandar and Halalli, 2015). Lowpass will produce a Gaussian smoothing blur image meanwhile high pass filter will increase the contrast to sharpen the image.

Following that, various applications or tools are developed for image processing. They are MATLAB, GNU Octave, OpenCV, Scikit-Image and Scilab. Pattnaik (2018), MATLAB is the most of flexible software to perform image processing. The name MATLAB comes from “Matrix Laboratory”, a fourth-generation high-level programming language developed by MathWorks(U.S). Every aspect of computational mathematics can be handled in MATLAB. Ragini Bhat and Bijender Mehandia uses this software to conduct their research. They exported the data into a text file for further analysis of the output. Although MATLAB is popular, it is not open source. License will be needed to use MATLAB and to acquire such license you would have to pay.

Rather than using a computer to do the plate number recognition, they also used mobile platform (Mutholib A. et al, 2012). Image was acquired using the camera available with the mobile, and it undergoes image processing such as contrast enhancement, filtering and in the end optical character recognition (OCR) for recognizing the plate numbers. On the other hand, another team that used a mobile device with OpenCV imported into the android program (Hung Ngoc et al, 2016).

The other software that is available for plate number recognition is OpenCV. It is an Open-Source programming library geared mostly at real-time computer vision.

It is written in the C++ programming language. Sweta Kumari, Leeza Gupta and Prena Gupta used this software for their automatic license plate recognition research on the computer. Under the open-source BSD licence, the library is cross-platform and free to use. System such as face recognition, gesture recognition, human-computer interaction, mobile robots, segmentation, and other uses of OpenCV.

2.4 Proposed Solution/ further project

Based on the previous system on plate number recognition, image filtering can help increase the readability of the plate numbers. Image filtering techniques on morphology filtering were used has helped improve the plate number to be recognized (Kaur Sarbjit and Sukhvir Kaur, 2014). According to Chandel and Gupta, image filtering allows for a variety of helpful image processing tasks. The project will be focused on the various technique of image filtering that is somewhat similar to each other in terms of its objective. Analysis will be conducted to get which technique produce the best result. The methodology on this project is image acquired will undergo several image processing before recognition phase such as converting RGB to grey scale, image filtering for three techniques, character segmentation and template matching for character recognition.

2.5 Conclusion

The chapter includes a profound understanding of how researchers tweak the plate number recognition system. Few software and hardware used are discussed and justification on the plan of this project. Plate number recognition will help understand the concept of image processing techniques and could be applied for other types of recognition such as fingerprint recognition, face recognition and so on. Next chapter will be talking about how the project will be done.

CHAPTER 3

PROJECT METHODOLOGY

3.1 Introduction

This chapter emphasis on the methodology of the project that was conducted. The analysis was based on the percentage of the characters that are correctly been recognized by the algorithm. Manually blurred plate number images were collected and used. The same collected images was processed on all three different filtering techniques to find out which technique has the best recognition percentage.

3.2 Methodology

The project consist of 5 phases, converting image to grey scale, image filtering, image binarizing, detecting edges of image, character segmentation and character recognition. Figure 3.1 shown is the general approach to process the image in this project for plate number recognition.