

INTELLIGENT PARKING MANAGEMENT SYSTEM

(IPMS)

OON CEE XIAN

**A report submitted in partial fulfillment of the requirements for the Degree
of Electrical Engineering (Control, Instrumentation, and Automation)**

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2012

ACKNOWLEDGEMENT

In preparing this report, I was in contact with many people, researchers, academicians and practitioners. They have contributed towards my understanding and thought. In particular, I wish to express my sincere appreciation to my main project supervisor, En. Norazhar Bin Abu Bakar, for encouragement, guidance critics and friendship. I am also very thankful to my co-supervisors En. Mohamad Riduwan Bin Md Nawawi, En. Aminurrashid Bin Noordin, En. Khalil Azha Bin Mohd Annuar, En. Musa Bin Yusup Lada and Associate Dr. Abdul Rahim bin Abdullah for their guidance, advices and motivation. Without their continued support and interest, this project would not have been same as presented here.

I am also indebted to University Teknikal Malaysia Malacca (UTeM) for their assistance in supplying the relevant literatures. My fellow undergraduate students should also be recognized for their support. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family members.

ABSTRACT

The growth of technologies requested higher performance tools in order to fulfill human needs and market. This system is implemented to make human work easier besides can reduce the uses of human power and because of its potential application. The development of automatic car license plate recognition system will resulted greater efficiency for vehicle monitoring system. Car plate recognition systems are used commercially, both in overseas and locally. In Malaysia, however the usage of car plate recognition system is restricted to the ordinary car plates. This means that the system is unable to detect special types of car plates. Therefore, this system is aimed for implementation of a recognition system for special Malaysian car plates. This system is implementing by using MATLAB R2008a Image Processing Toolbox, which uses optical character recognition on images to read the license plates on vehicles. The system is an online system where the image will automatically extracted once after the image is captured by webcam using image processing technique. First, the image is converted into a binary image and then the chosen area will be cropped so that only the plate number is left .Next, the image is compliment so that the black plate background becomes white while the white plate number becomes black because the system can only detect binary image where the background should be white while the plate number should be black. One of the important steps is the integration between image processing and Graphical User Interface (GUI) where, the output of this project will display using GUI.

I declare that this report entitle “*Intelligent Parking Management System (IPMS)*” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name :

Date :

To my beloved mother and family

Contents

ACKNOWLEDGE	ii
ABSTRACT	iii
TABLE OF CONTENTS	vi
CHAPTER 1	4
INTRODUCTION	4
CHAPTER 1	1
INTRODUCTION	1
1.1 Introduction.....	1
1.2 Problem Statement	2
1.3 Project Objective.....	3
1.4 Project Scope.....	3
CHAPTER 2	4
LITERATURE REVIEW	4
2.1 Project Background.....	4
2.2 Type of License Plate Number.....	4
2.3 License Plate Recognition Technology.....	6
2.4 MATLAB.....	7
2.5 Digital Image Processing	7
2.5.1 Pre-processing.....	8
2.5.2 Edge Detection.....	9
2.5.3 Threshold	10
2.5.3 Type of Method	10
2.5.4 Character segmentation	10
2.5.5 Hough Transform.....	11
2.6 Neural Network Technology.....	12
2.6.1 Procedures for Character Recognition.....	13
2.6.2 Training Algorithm: Back-propagation	14

2.7	System Development Requirements	14
CHAPTER 3.....		16
METHODOLOGY		16
3.1	Introduction.....	16
3.2	Flow Chart.....	16
3.3	Design	18
3.4	Input Image	19
3.5	Pre-processing.....	20
3.5.1	Resize Image.....	20
3.5.2	Color Image to Grayscale Image	21
3.5.3	Adjust Threshold Image	22
3.5.4	Grayscale Image to Binary Image	23
3.5.5	Filter Image First Round.....	23
3.5.6	Filter Image Second Round	24
3.6	Plate Region Extraction	25
3.6.1	Histogram of the Second Round Filtered Image	25
3.6.2	Crop the License Plate Region	26
	Figure 3.10: Image of License Plate Region	26
3.7	Characters Segmentation.....	26
3.8	Character Recognition.....	27
3.8.1	Create Template	27
3.8.2	Resize the Template.....	28
3.8.3	Train the data using Neural Network.....	28
3.8.4	Recognise the Characters.....	29
3.9	Developing MATLAB GUI.....	29
CHAPTER 4.....		31
RESULTS		31
4.1	Introduction.....	31
4.2	License Plate Recognition Results.....	31
4.3	GUI Display Result.....	34
4.4	The Accuracy of Recognition	35

4.5 Summarize of the Accuracy of Recognition for All Testing	39
CHAPTER 5.....	40
ANALYSIS AND DISCUSSION	40
5.1 Analysis.....	40
5.2 Discussion	42
CHAPTER 6.....	44
CONCLUSION AND RECOMMENDATION	44
6.1 Conclusion	44
6.2 Recommendation	44
REFERENCE	46
APPENDIX.....	47

LIST OF TABLES

TABLE	TITLE	PAGE
4.1	Test Results of Intelligent Parking Management System Statistics	35
4.2	Summarize of the Accuracy of Recognition for All Testing	39

LIST OF FIGURES

FIGURE	TITLE	PAGE
2.1	Standard size for plate number set by JPJ	5
2.2	(a) Samples of common Malaysia license plates.	6
	(b) Samples of special Malaysia license plates.	6
	(c) Samples of taxi license plates.	6
	(d) Horizontal license plate form	6
	(e) Vertical license plate form.	6
2.3	Sobel masks for edge detection, (a) Vertical, (b) Horizontal	9
2.4	Two layer feed –forward Neural Network	12
2.5	Flow of the processes in the character recognition	13
3.1	Flow Chart of this project	18
3.2	License Plate Recognition Process	19
3.3	Input Image	19
3.4	The flow for Pre-processing Process	20
3.5	Resize Image	21
3.6	Grayscale Image	22
3.7	Adjusted Threshold Image	22
3.8	Grayscale Image to Binary Image	23
3.9	First Round Filtered Image	24
3.10	Second Round Filtered Image	24
3.11	Histograms of Second Round Filtered Image	25
3.12	Image of License Plate Region	26
3.13	Image Cropped Characters	26
3.14	Example of the sample of characters	27
3.15	GUI Neural Network Toolbox	28
3.16	The successful License Plate Recognition	29

3.17	Example of the GUI for this project	30
4.1	Result (i) of Successful Recognition	31
4.2	Result (ii) of Successful Recognition	32
4.3	Result (iii) of Successful Recognition	32
4.4	Result (i) of Unsuccessful Recognition	33
4.5	Result (ii) of Unsuccessful Recognition	33
4.6	Result of GUI display during car entrance	34
4.7	Result of GUI display during car exit	34

CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, parking has become an essential aspect of transportation planning. There's a lot of area which have growth explosively with customers and visitors as result of urban revitalization, uptown development and the general trend toward increased mobility of our society.

The Intelligent Parking Management System (IPMS) is implementing the new technology of image processing in parking management system which it called Automatic License Plate Recognition to the civilians Malaysia. It has plays the main role to provide a convenience parking services to public. This IPMS project is developed based on the research in existing traditional parking system which requires parking coupon. From the traditional system, I have realized that a lot of issues happened because of the parking coupon, so this project is purposely implemented to overcome the problem. This project is emphasis the best solution to replace the use of paper or token for parking. IPMS has invented to automate the parking management system so that customers no need to take the parking coupon while enter or exit the building and in the same time customers able to prevent from the inconvenience issues happened on themselves. It also will calculated the total amount of the parking fees automatically after customers have entered their license plate number on the autopay machine.

Automatic Number Plate Recognition has variety of applications can be applied since the license number is the primary, most widely accepted, human readable, mandatory identifier of motor vehicles. ANPR provides automated access of the content of the number

plate for computer systems managing databases and processing information of vehicle movements. Below I indicated some of the major applications, without the demand of completeness.

1.2 Problem Statement

Most of the parking system in building such as bank, shopping center and private office require parking coupon and usually the parking management system are still require human effort. For example, while customers reach the entrance or exit gate of the building, they still have to scroll down the window to take the parking coupon by their own self to enter or exit. Not only nowadays system still needs human effort, the parking coupon itself also has brought out a lot of inconvenience issues to customer while using the system. One of the issues that happened commonly is the customers has lost or misplaced their coupon, they will be charged for the penalty fees which cost about RM30 to RM50. Besides that, sometimes while customers doing payment, there's a defect on parking coupon occurred which the autopay machine can't verified the coupon and cause the customer require to go to the management department for verification. Furthermore, customers occasionally left their parking coupon in their vehicle, thus they need to walk a long way to their vehicle to get the parking coupon and back to station with long queue again. Therefore, the building such as shopping mall always received many complain from customers because of wasting time in the parking lot because of those issues. So, this project is invented to resolve those inconvenienced issues to happen. The main role for the project is to automate the parking management system by using Automatic License Plate Recognition and in the same time provide a ticketless parking management system. Thus, while the parking management system has eliminated the usage of coupon, automatically all the troubled parking coupon issues will be resolved and bring convenience situation to customer.

1.3 Project Objective

The aim of this project is to study and design efficient license plate recognition for parking management system using MATLAB. Project objectives are listed as follows:

- To develop the nowadays parking management system using license plate recognition technology.
- To compare efficiency between the proposed system and the manual system.
- To study and understand pattern recognition of simple shapes using license plate in this applications like identification, detection and recognition.
- To provide an automated parking management system which are practical, reliable, and eliminates disturbance and time loss in traditional parking management system.

1.4 Project Scope

The scope of the project is developed an algorithm to identify the characters from the license plate by using the MATLAB software. The mechanisms for this project are using personal computer to integrate all the software, and a network camera is used to capture the real-time video into personal computer for license plate recognition process. This project will focus on the process of recognition on license plate by using neural network method in MATLAB. In practical, this system is designed to save time, eliminate parking coupon issues and human effort.

CHAPTER 2

LITERATURE REVIEW

2.1 Project Background

This chapter will focus more on the literature survey. It will introduce the definition, the history of the technologies and parking system with a focus on license plate recognition. In addition, a study of previous parking systems and its atomization attempts was conducted to examine the similar previous systems. The literature is divided into three main parts; the first part examines the different license plate characteristics. After that, an in-depth study on license plate recognition is conducted and the process to be used by my proposed project. The final portion of this literature review presents the method of recognition part, where I use an artificial Neural Network to recognize the characters on the license plate.

2.2 Type of License Plate Number

Generally, there are many types of vehicles such as motorcycle, car, taxi, lorry, tractor and so on. A license plate number or also called number plate is a small metal or plastic plate attached to a motor vehicle for official identification purposes. On each vehicle, it must be appeared in pairs, with the one attached at the front and another one attached at the rear. The license plate has an alphanumeric number on it, which is specific for the vehicle. For each vehicle, it must follow the specification that has been approved by Department of Road Transport (JPJ).

In Malaysia, for normal vehicle such as personal car it has plate number with black color for the background and the font color is white, while for taxi is the background color of plate number is white and the font color is black [9]. Vehicles license plates are in the form of vertical or horizontal with normal fonts that has been standardized by JPJ which comprise of perhaps 90% of the all vehicles as shows in Figure 2.1. There are also taxi plate number and special fonts as shows in Figure 2.2.

According to the project of by Jasiha Nor Binti Jamaludin [2], and by Wisam Al Faqheri and Syamsiah Mashohor [3], they were focus on their project with horizontal license plate form while the project by Othman Khalifa, Sheroz Khan, Rafiqul Islam and Ahmad Suleiman [7], and by Siti Norul Huda Sheikh Abdullah, Marzuki Khalid and Rubiyah Yusof [5], they were use both of license plate form. All of them were also focus on car license plate only. So that, in this project will also focus on car license plate and horizontal car license plate form.



Figure 2.1: Standard size for plate number set by JPJ

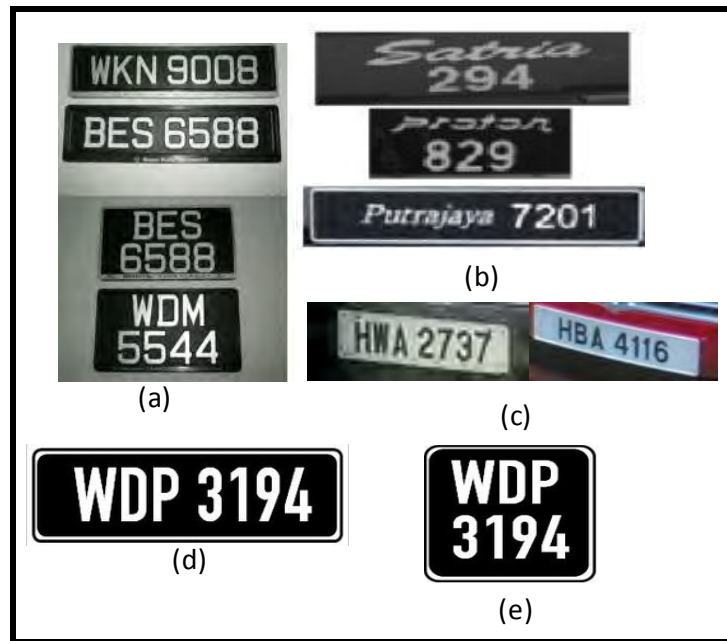


Figure 2.2: (a) Samples of common Malaysia license plates. (b) Samples of special Malaysia license plates. (c) Samples of taxi license plates. (d) horizontal license plate form (e) vertical license plate form.

2.3 License Plate Recognition Technology

According to Lee J. Nelson [10], License Plate Recognition (LPR) is one form of ITS technology that not only recognizes and counts vehicles, but distinguishes each as unique. For some applications, such as electronic toll collection and red-light violation enforcement, LPI/R records license plates alphanumeric so the vehicle owner can be assessed the appropriate toll or fine. In others, like commercial vehicle operations or secure-access control, a vehicle's license plate is checked against a database of acceptable ones to determine whether a truck can bypass a weigh station or a car can enter a gated community or parking lot.

License plate recognition (LPR) is a new tool for automatic vehicle and traffic monitoring by using digital image processing. For implementing LPR system I have used digital image processing technique and artificial neural network. The LPR system can be used to traffic control management for recognize vehicles that commit traffic violation, such as

entering restricted area without permission; occupying lanes reserved for public transport, crossing red light, breaking speed limits; etc.

The purpose for which this system is implemented real time applications, this system is using advance and new techniques of digital image processing such as pattern recognition for recognize characters of license plate and artificial neural network to extract the data.

2.4 MATLAB

MathWorks has created a numerical computing environment and programming language which called MATLAB. This software allows easy matrix manipulation, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs in other languages. Although it is numeric only, an optional toolbox interfaces with the Maple symbolic engine, allowing access to computer algebra capabilities.

MATLAB is built around the MATLAB language, sometimes called M-code or simply M. The simplest way to execute M-code is to type it in at the prompt, `>>`, in the Command Window, one of the elements of the MATLAB Desktop. In this way, MATLAB can be used as an interactive mathematical shell. Sequences of commands can be saved in a text file, typically using the MATLAB Editor, as a script or encapsulated into a function, extending the commands available. This project could be successfully implementing an initial program to recognize car plate using MATLAB. Image Processing Toolbox and Neural Network Toolbox are used to implement the system.

2.5 Digital Image Processing

Digital Image Processing approach concerns stages of pre-processing, edge detection, filtering, detection of the plate's position, slope evaluation, and character segmentation and recognition. Single frame gray-level images are used as the only source of information. There are four primary algorithms that the software requires for identifying a license plate:

1. Plate localization – responsible for finding and isolating the plate on the picture

2. Plate orientation and sizing – compensates for the skew of the plate and adjusts the dimensions to the required size

3. Normalization – adjusts the brightness and contrast of the image

4. Character segmentation – finds the individual characters on the plates

The complexity of each of these subsections of the program determines the accuracy of the system. During the third phase (normalization) some systems use edge detection techniques to increase the picture difference between the letters and the plate backing. A median filter may also be used to reduce the visual "noise" on the image.

2.5.1 Pre-processing

The original image/input image is generally in a large pixel. Therefore, that input image need to crop/resize. According to Mohd Firdaus Zakaria et. al. [4], they done this step on their project in order to minimize the processing time, the original image/input image has been cropped just only fifty percent of the lower part of the input image will be processed. This is because the upper part does not contain a plate number area.

There are various problems with various image of license plate such as license plate can be dirty, the car can be of a bright color, poor lighting and so on. Hence, the captured image need to pre-processes based on some approaches. Pre-processing is very important step for the good performance of character segmentation. According to the project by Norfaeza binti Mat Noor [6], and by Othman Khalifa, Sheroz Khan, Rafiqul Islam and Ahmad Suleiman [7], they stated that input image is initially processed to improve its quality and prepare it to next stages of the system. First step, they were used NTSC standard method to convert RGB images to gray-level images:

$$\text{Gray} = 0.299 * \text{Red} + 0.587 * \text{Green} + 0.114 * \text{Blue} \quad (1.0)$$

Second step, to remove the noise, while preserving the sharpness of the image they applied median filter (5 x 5) to the gray-level image. The median filter is a non-linear filter,

2.5.3 Threshold

One of the early techniques for image segmentation, the threshold would be based on the distribution of gray levels in the image that is composed of bands of gray levels that are normal. Segmentation is done by dividing the band outside the area have the same gray-level images reminder [2]. To converts the grey scaled image into binary image, threshold technique must be done so it can be segmented into foreground and background region. Binary images are much simpler to analyze because the geometrical patterns and objects in the images can be identified easily since they are not cluttered with shading information.

2.5.3 Type of Method

There are several methods are used for image processing on license plate detection have been done by researcher such as color features, pattern matching [1], template matching [4], Hybrid Fuzzy [3], edge information, character segmentation [8], Hough transform [2], neural network [5] [6] [7].

2.5.4 Character segmentation

According to project by Stephen Karungaru, Minoru Fukumi and Norio Akamats [8], character segmentation is a process by which the areas that are thought to contain characters are extracted from the license plate. The license plate recognition methods are then applied only inside the segmented regions speeding up the search. For recognition methods (for example template matching) that rely on the number of characters and the size of the extracted region to set their parameters, character segmentation must be accurate otherwise the results of recognition will not be acceptable. In their work, image smoothing and histogram threshold methods was used to performed the character segmentation.

According to project by Othman Khalifa, Sheroz Khan, Rafiqul Islam and Ahmad Suleiman [7], they used this step to segment the characters of the license plate:

- i. Stretch the contrast of the image to extend over the entire range of gray levels available (0-255).
- ii. Threshold the license plate image using Otsu method.
- iii. Search the connected components in the image, each connected component will be assigned a special label in order to distinguish between different connected components in the image.
- iv. They resize each character from the previous step to the standard height and width (20x10) in order to use in the following recognition process.

2.5.5 Hough Transform

This method was used by Shokri Gendy, Clifton L. Smith, and Stefan Lachowicz [2] and by Othman Khalifa, Sheroz Khan, Rafiqul Islam and Ahmad Suleiman [7] on their project. The function of Hough Transform is to define the correction of skew angle. It consists of some formula of calculation which were used to calculate the correction of skew angle.

2.6.1 Procedures for Character Recognition

The proposed character recognition module consists of three steps, which are training characters, comparing characters, and verifying characters. Figure 2.5 shows the flow of these steps in the character recognition.

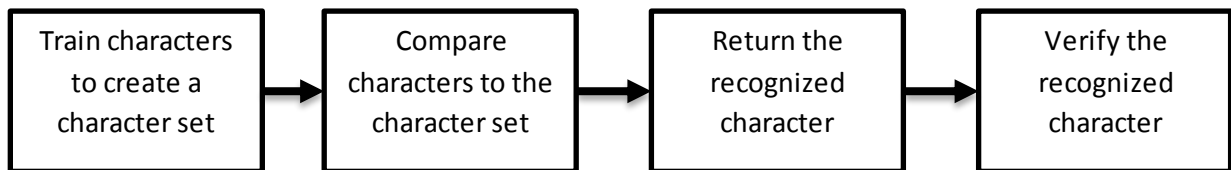


Figure 2.5: Flow of the processes in the character recognition [5]

Training characters is the process by which the machine is trained with different types of characters and patterns appeared on the license plates that will be read in during the comparing procedure. A character set will be created once characters are trained. The set of characters is later compared with objects during the reading and verifying procedures. The neural network must be trained to suit the LPR with recognition achieved in an acceptable time. This can be done by using a training algorithm, which will adjust weights to come out with one correct output solution and downgrade all others. Comparing characters is the process by which the LPR application analyzes the segmented characters to determine if they match the characters stored in the character training set. If a character in the character set matches the segmented object, the recognition will return the character value of that character and a nonzero confidence score. If no character in the character set matches the segmented object, the recognition will return the substitution character as the character value and return a confidence score of zero.

Verifying characters is a process by which the LPR application inspects the segmented characters to verify the quality of the characters it has compared. The confidence score created during the comparing process will be checked. It indicates the degree to which the assigned character represents the input object better than other characters in the character training set.