CAR PLATE DETECTION SYSTEM

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A report submitted in partial fulfillment of the
requirement of the award of the degree of
Bachelor of Computer Technology (Software Engineering)

Faculty of Computer System & Software Engineering
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MARCH, 2005

ABSTRACT

Car Plate Recognition System is an image processing system in which it locates and recognizes a car plate. This technology is still new and only few systems are available in Malaysia. The most crucial part in Car Plate Recognition System is plate location. This is because if the system fails to detect the location of the car plate, then the whole system is a failure because recognition can only be done after successful plate location. Therefore, this research is mainly focused on plate location. In short, this research is entitled *Car Plate Detection System*. This system will focus on 4 major parts of pre-processing phase which are Image Enhancement using median filtering, Thresholding using global threshold value, Feature Extraction using thresholding, and Plate Location using rule-based conditions. This system was developed as a prototype to fulfill the requirement and prove the correctness of the algorithms used. The data or car plates used are strictly typical Malaysian civilian car plate numbers. Image is acquired using digital camera and fed to the system which thresholds the image to convert it into the binary image. Feature extraction is performed to produce the features of the binary image. Finally, the location of the car plate is located using rule based algorithms. The conditions are set as rule and the system detects the car plate if the condition exists. The results are discussed in Chapter 4.

ABSTRAK

Sistem pengecaman nombor plat kereta adalah satu sistem yang menggunakan pemprosesan imej di mana sistem ini mencari lokasi plat kereta mengecam setiap aksara dalam plat tersebut. Teknologi ini masih dalam perkembangan dan masih baru di Malaysia. Pengesanan lokasi plat kereta merupakan bahagian yang paling kritikal kerana sekiranya sistem ini tidak dapat mengesan lokasi, maka fasa pengecaman akan turut gagal. Oleh yang demikian, kajian yang dilakukan adalah lebih tertumpu kepada fasa pengesanan lokasi plat kereta, dan dengan ini prototaip sistem yang akan dibangunkan telah dinamakan *Car Plate Detection System*. Prototaip ini akan memfokus kepada 4 bahagian utama iaitu pemulihan imej menggunkan teknik median, ambangan menggunakan nilai ambangan global, pengeluaran ciri meggunakan teknik ambangan, dan pengesanan lokasi nombor plat menggunakan teknik peraturan. Sistem yang dibangunkan merupakan prototaip sistem sebenar dan dibangunkan bagi menepati kehendak skop kajian. Nombor plat kereta yang digunakan terdiri daripada nombor-nombor plat kereta biasa di Malaysia. Imej plat kereta di ambil menggunakan kamera digital dan dimasukkan ke dalam sistem yang mana sistem akan melakukan ambangan dan menukarkan imej kepada imej binari. Pengeluaran ciri dilakukan bagi menghasilkan ciri-ciri daripada imej binari. Akhir sekali, pengesanan lokasi plat kereta dilakukan menggunakan kirteria-kriteria tertentu. Keputusan dan perbincangan mendalam telah dilakukan di dalam Bab 4.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

KUKTEM	-	Kolej Universiti Kejuruteraan & Teknologi Malaysia
UTEC	-	University College of Engineering & Technology Malaysia
3D	-	3-Dimension
2D	-	2-Dimension
MSC	-	Malaysian Super Corridor
CARPROS	-	Car Plate Recognition System
AI	-	Artificial Intelligence
CCD	-	Charged Coupled Device
SDLC	-	Software Development Life Cycle
JPEG	-	Joint Photographic Expert Group
BMP	-	Microsoft Bitmap
TIFF	-	Tagged Image File Format
RGB	-	Red, Green, and Blue
JPJ	-	Jabatan Pengangkutan Jalan

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

These days a lot of effort is spent on converting the normal human vision into machine vision. A lot of researches have been conducted throughout the world and this field is still expanding from time to time. Due to our human vision's limitation, many works could not be performed since our naked eyes have limited viewing capacity in terms of distance and there are chances for miss interpretation. Therefore, it is learned that machine vision can assist humans to perform specific tasks that could not be performed by human eyes.

Machine vision is actually an application which does not require human input on most cases, although humans are involved in the development of these applications. Once completed, machine vision application does all the necessary computations and produce results as required and with minimal input of information from human. The goal of machine vision is to create a model of the real world images. Since the image that human eyes perceive is 3D, a machine vision system uses 2D representation of the data to extract useful information from the images.

These days, there are many machine vision application exists. Each application extracts information differently according to its functions and purposes. Machine vision application supports many business types ranging from medical, aerospace, geology, manufacturing and also production. For example, the application that is purposed for medical field is used to perform X-Ray, scanning for brain tumor and also for laser operations and automated surgical processes as described by Gonzalez. C.R and Richard. E.W (2002). In geology field, machine vision is used to get and translate satellite images taken from space. The images are used to look for changes in whether, earth's plate movements and also to detect natural disasters.

Although some of these tasks can be performed by normal human eyes, it might take time. Therefore, machine vision has proved its advantages and benefits. More importantly, machine vision is used in security field and to strengthen laws. For example, there are applications installed at traffic lights that can take pictures of cars which run the red lights. Besides that, there are also applications which can provide tight security systems for highly confidential organizations. These include applications like fingerprint recognition entrance, biometrics access, and secured building access using car plate recognition system.

Going in detail on car plate recognition system, it is a complex machine vision application which recognizes the characters on a car plate based on the given conditions and instructions. The car plate recognition system is installed in many places such as toll gates, parking lots and also entrance of highly secured buildings. Even polices are using this application because they can detect speeding vehicles from distance away.

Car plate recognition systems are beneficial because it can automate car park management, improve the security of car park operator and the users as well, eliminate the usage of swipe cards and parking tickets, improve traffic flow during peak hours, improve airport security where limiting drop-off zone parking for five minutes only, detect speeding cars on highways, and detect cars which run over red traffic lights.

Realizing the importance of car plate detection, it is recommended that a research is conducted in this application since in Malaysia, the development of image processing applications are still inadequate. Since Malaysia is venturing into the IT world these days, the government has always been supporting the usage of computerized systems throughout the nation. This can be proved by the famous MSC or known as Malaysian Super Corridor and also by the automation of government departments throughout the nation. Therefore, developing a computerized system in the field of image processing will be quite a new venture.

In this research, the prototype development for the Car Plate Detection System is divided into 4 major phases of image processing. The model was based on the paper entitled *The Automated Inspection of Moving Webs Using Machine Vision* by (Wayne, 1995). The original model was developed for developed to detect defects in material but this model was modified to suit the purpose of Car Plate Detection System. Each phase is inter-related with each of the other phases. The diagrammatic view of the whole processes involved is shown on Figure 1.1.

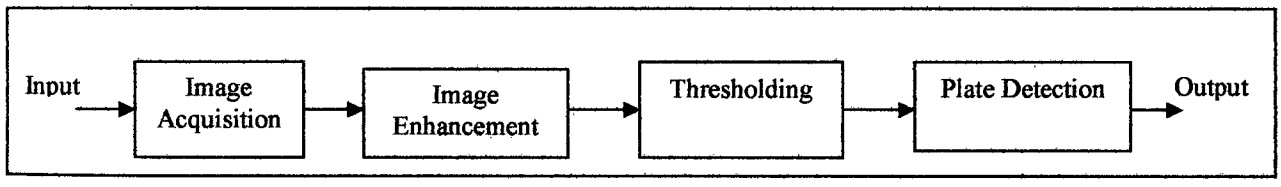

Figure 1.1 Main phases of image processing involved in Car Plate Detection System suggested by Wayne (1995)

The *Car Plate Detection System* will be developed based on the case study method. The environment that will be used to do the case study is University College of Engineering & Technology of Malaysia (UTEC), Gambang, Kuantan. This system is an image processing and recognition system that will capture the vehicle number plate and match the numbers with the vehicle owners. The initial plan for this system is to have a complete database whereby each car's information is fed into the system. The system will then detect the owner's information based on the car plate detected. The complete system with the database will be called as "CARPROS – *Car Plate Recognition System*".

CARPROS is divided into two main modules. The first module is pre-processing whereby the car plate image will be prepared for mathematical operations, located and extracted from the existing image. This whole module is called "*Car Plate Detection System*". Meanwhile, the other module will focus on segmentation of the car plate character and recognition. Combining these two modules, it will give CARPROS.

The technology that will be used to develop the *Car Plate Detection System* is a combination of Image Processing and Artificial Intelligence (AI). The image processing techniques that are applied is basic pre-processing techniques, meanwhile the AI techniques that are applied for plate extraction is rule-based. The use of this AI technique is because there are many conditions for plate extraction.

1.2 Problem Statement

Plate detection is the most important part in an automated car plate recognition system. Failure to detect the location of the plate will eventually fail the entire system. A good and reliable algorithm has to be produced in order for the system to be reliable and fast. The initial image size that is fed to the system is 640 x 480, *gray-scale* image. The color of the image is changed into black and white and proper algorithm has to be applied for exact location and extraction of car plate.

The existing method used in University College of Engineering & Technology Malaysia when detecting vehicles is by using the obsolete sticker system. Each car is given a sticker which contains the car number plate number and this is used as reference when it comes to detect a vehicle in the campus. Staffs uses stickers with blue background meanwhile students use stickers with red background. Failure to display this sticker will be compounded. Whenever there is a visitor, or a car needs to get into the main campus gate, guards need to be at the post to operate the gate.

As a solution, CARPROS should handle the job of handling traffics in and out of the campus. Since CARPROS has a lot benefits, it can be implemented as it can automate the process of controlling the traffic. Besides that, it will be easier to monitor the traffic activity in and out of the campus. In order for CARPROS to be implemented, the "*Car Plate Detection System*" should be developed first. It is very important for this sub-system to be developed properly since this module houses the algorithm for plate detection.

1.3 Objectives

The main objective of the project is to:

a. To develop a prototype of *Car Plate Detection System* focusing on:

   i. Thresholding using global threshold value.
   ii. Filtering using median filtering.
   iii. Feature extraction using thresholding.
   iv. Car plate location detection using rule-based technique.

1.4 Scopes

The scope of the project is limited to the pre-processing phases which include 4 major steps. The main focus of the scope is to develop a prototype of "*Car Plate Detection System*" focusing on pre-processing phases. This prototype will be developed fully using MATLAB Version 6.1 and a little aid from Adobe Photoshop CS. The following are the additional scope for this project:

a. Images are in JPEG format.
b. Only grayscale image is fed into system.

c. Images taken had fixed length between the camera and the number plate (≈ 1.5m).

d. The plate used for testing is only single-line car plates. Refer Figure 1.2.

e. Only clean car plates were used for testing.

f. Only civilian car plates were used.

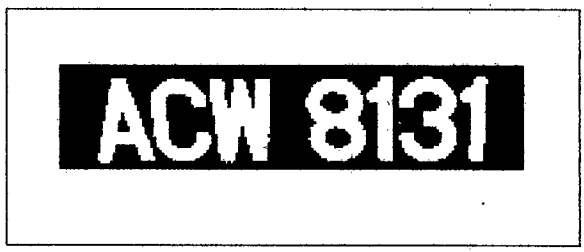

Figure 1.2 Single Line Car Plate

1.5 Thesis Organization

The thesis is divided into 5 essential chapters ranging from Chapter 1 until Chapter 5. The Chapter 1 gives an overview of the research conducted. It also discusses the problem statement, objective and the scope of the research. Meanwhile, Chapter 2 reviews the previous research works conducted by many researches outside. All the relevant researches taken from technical paper, journals, and books are discusses in detail. Chapter 3 reveals the techniques and the algorithms that are used to perform this research. It also discusses the process flow of this research in detail. All the results of the testing is detailed out in Chapter 4. Finally, the Chapter 5 concludes the entire thesis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Nowadays, car plate detection is being the baseline for any car plate recognition system. Without this whole detection process, it is almost impossible to complete a car plate recognition system. This actually, implies to all the recognition system like texture recognition, fingerprint recognition and many other recognition system.

The detection system enables us to capture the image and prepare the image for it to be understood by the recognition system. This is essential as it helps us to make the whole recognition process easier because the images will be filtered for noise and will be detailed for easier detection and recognition.

In this thesis, references have been made from various technical papers related to car plate detection and recognition. In short, most of the technical papers emphasizes on few aspects as the most critical portion of the whole image detection process. One of the most important aspects is the algorithm for image processing as it

involves various steps such as image filtering, thresholding and thinning. Therefore, all these aspects have been laid out in detail in the following sub-chapters.

In Malaysia, there are 3 types of car plates. The types of the plate depends on the usage of the car; (1) General civilian car possess a black background and white for character, (2) Taxi posses white background and black characters, and finally (3) Diplomat's, International Rubber Association, and PBB's car posses red background with white characters.

The Road and Transport Department of Malaysia have given guidelines and specification for the car plate measurements. The list of important criteria's and specification on a civilian car plate is showed in Table 2.1 meanwhile the detail graphical representation of car plate is shown on Figure 2.1. The figure shows 3 types of civilian car plate measurements that have been released and standardized by the department.

Table 2.1 : Specific plate measurement and criteria of car plate

No.	Specification	Measurement (mm)
1.	Character Height	70
2.	Character Width	40
3.	Distance between characters / numbers	10
4.	Single-line plate: Distance between character and number	30
5.	Dual-line plate: Distance between character row and number row	10
6.	Minimum clearance between character and top-edge and bottom-edge of plate	10
7.	Minimum clearance between character and left-edge and right-edge of plate	10

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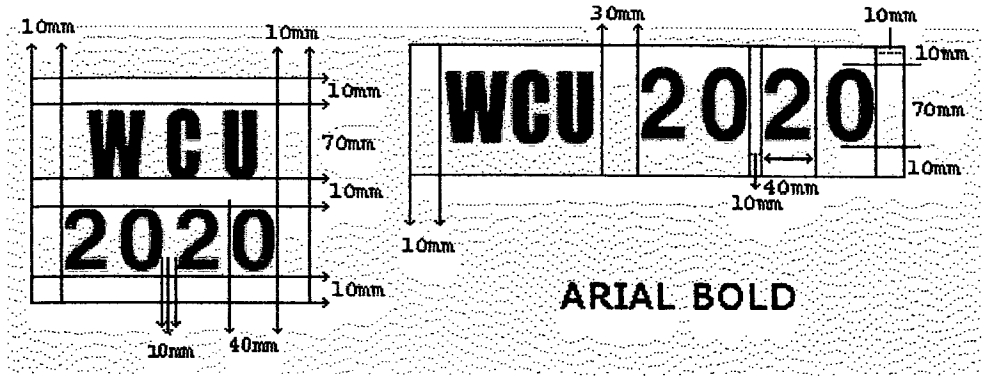

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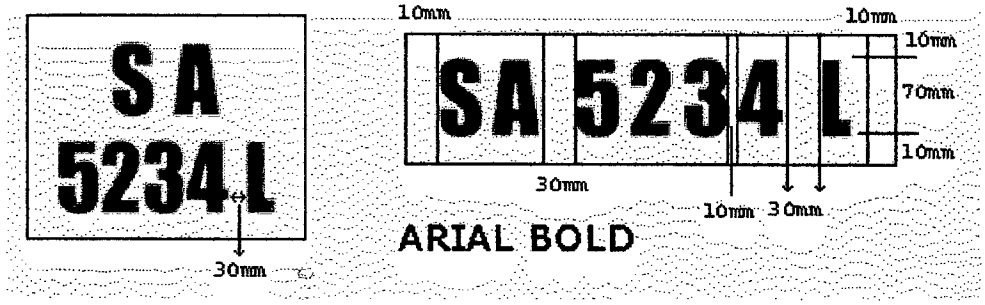

SARAWAK

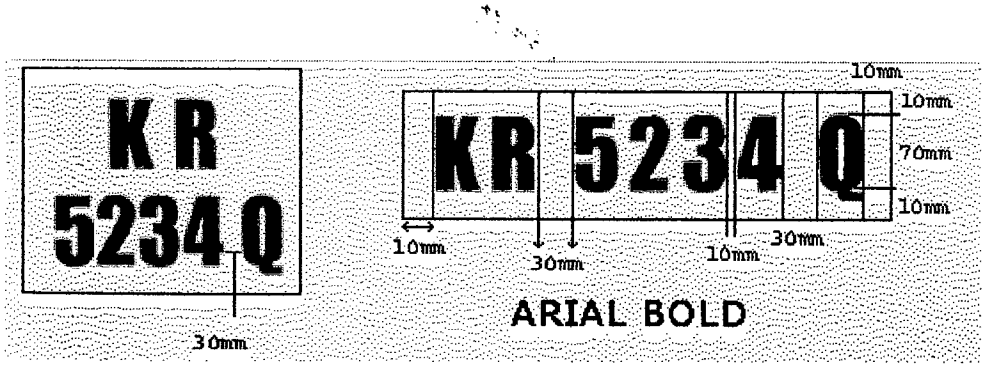

Figure 2.1 Malaysian car plate specifications

2.2 Image Analysis

In computer vision, one of the most important fields is image analysis (Umbaugh, 1998). Image analysis involves data analysis of an image and its purpose is to solve imaging problems in any applications. Therefore, image analysis is a very important aspect in image processing.

Image can be determined as a collection of matrix data. For example, image can be represented in many form such as 2-D or even 3-D. But then, machine vision is used to recover useful information from its 2-D projection. According to (Dept of Physics, University of Edinburgh), the information that is extracted differs from each application. There are many applications that uses the machine vision such as Remote Sensing (satellite images of earth surfaces to detect whether changes or sea surface changes), Inspection and Automation (detecting defects in manufacturing, quality and safety inspection), Medical Imaging (X-Ray image analysis, tumor detection, and blood sampling), and Military applications(aircraft tracking, automated guidance system, and weapons control).

According to (Umbaugh, 1998), the process of machine vision is a continuous process whereby each process or flow is inter-related with each other. The flow/processes of the steps involved in machine vision can be seen Figure 2.2. Each of steps will eventually be explained in further details on Chapter 3: Methodology.

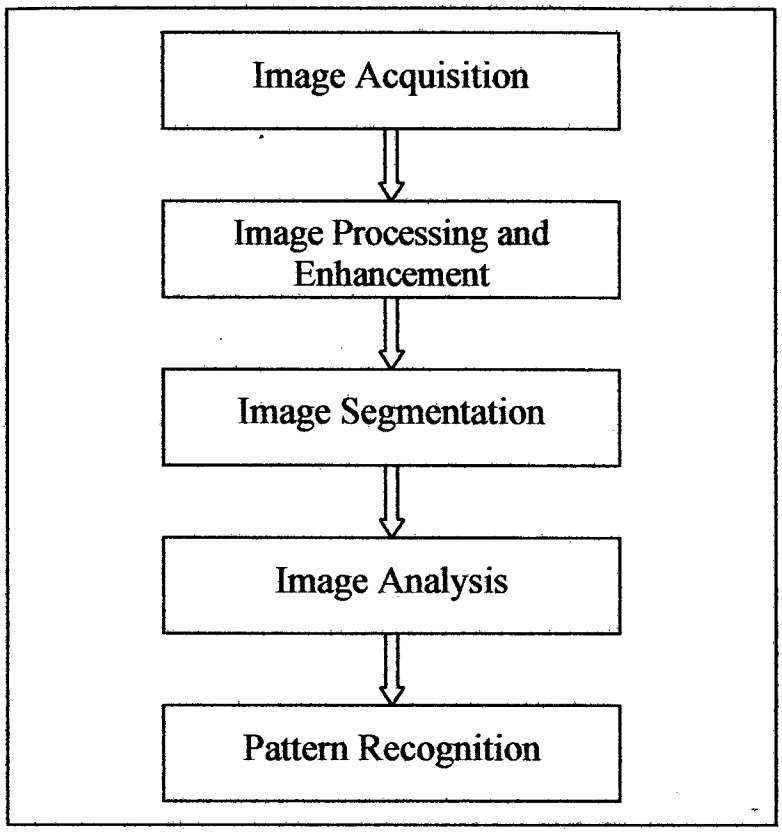

Figure 2.2 Steps involved in machine vision

2.3 Literature Review

Literature review acts as a good source of knowledge for this thesis. This is because by conducting the literature review, it can be said that the starting point in developing this car plate detection system was made easier. By conducting literature review, many aspects of car plate detection were identified including different algorithms and techniques of detection were used by many researchers. Some of the technical document referred was Byongmo Lee and Euiyoung Cha (2002), Fernando Martin and David Borges (1998) and Sorin Draghici (1997).

2.3.1 Complete Recognition System

According to Sorin Draghici (1997) in his research paper entitled *A neural network based artificial vision system for license plate recognition,* the approach used was to scan the image horizontally and look for contrast changes on a scale of 15 pixel[3] and more. He made the assumption that the contrast between the characters are in good view. Figure 2.3 shows the block structure of the whole system researched by Sorin Draghici.

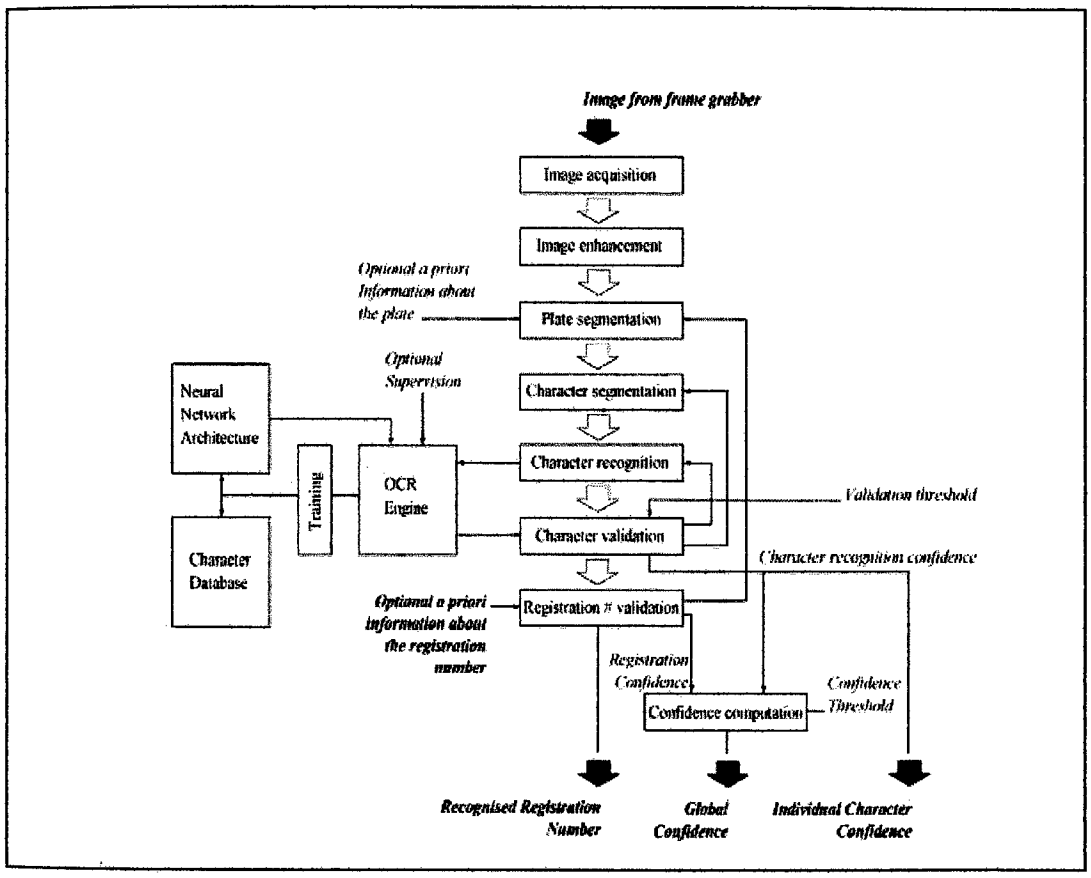

Figure 2.3 Block structure of system researched by Sorin Draghici

As for image acquisition and image enhancement, Sorin Draghici used Gaussion blur filter to remove the necessary noise in the image. The system then calculates and creates a histogram based on the equation and stretches the histogram with:

$$New\_Pixel = (Pixel * gamma) + beta \qquad (2.1)$$

where gamma and beta are calculated so that the stretched histogram will extend on the entire range of grey levels available.

The program then scans the image and searches the high contrast gradient at the given scale. Once done, the scan is repeated to look for concentrations of high gradient area. Therefore, the concentration can be approximated by a rectangle and called interest area. Once the subsequent processing is finished using the same method, the interest areas are enhanced through another histogram stretching. Figure 2.4 shows the sample images produced after the above technique of image enhancement.

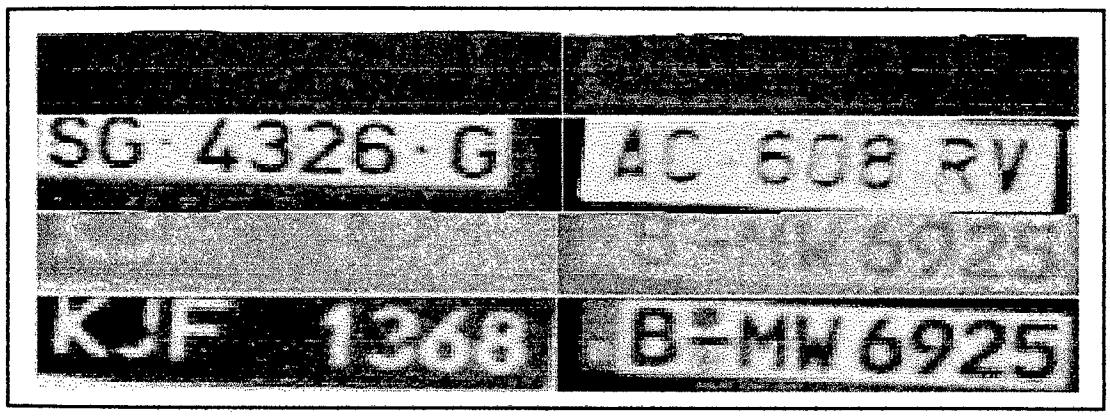

Figure 2.4 Sample images showing result of image enhancement

According to Byongmo Lee and Euiyoung Cha (2002) on their research paper entitled *Fast and Robust Techniques For Detection of Car Plate using HSV and Weighted Morphology*, pixels were extracted in rows and columns. Then, the noises were removed using median filtering. Figure 2.5 shows the flowchart of the plate detection system by this researcher.