CAR PLATE RECOGNITION SYSTEM BASED ON CHAIN CODE AND LOCAL SIGNATURE

LEE EE VON

A project report submitted in partial fulfilment of the requirements for the award of the degree of Master of Engineering (Electrical – Computer and Microelectronic System)

Faculty of Electrical Engineering
Universiti Teknologi Malaysia

MAY 2011
To my beloved family
ACKNOWLEDGEMENT

This project would not been successful without the support from many people. I would like to express my gratitude to the following persons who have offered invaluable helps and advices.

First of all, I would like to express my deepest gratitude to my project supervisor, Dr. Musa bin Mohd Mokji for his continuous guidance, patience and support for me throughout the project.

Besides, I would like to express my appreciation to Intel Microelectronics (M) Sdn. Bhd for funding my part-time Master study. Acknowledgement is also forwarded to my manager and colleagues for covering me while I was busy with project. Thanks for their understanding and endless support throughout my research. Last but not least, I would like to express my appreciation to my family for always inspiring me and motivating me.
ABSTRACT

Car plate recognition system has been developed to identify vehicles by the contents of their car plate for law enforcement nowadays. The application of the recognition system has wide variety where it is used as the vehicle access control, state border control and vehicle traffic monitoring. Since the usage model is wide, the accuracy of the recognition system is very important. This project is aimed for implementation of a car plate recognition system for standard Malaysia car plates using the chain code and local signature as the recognition technique. This system consists of several phases which are the car plate image extraction, car plate characters segmentation, database creation and character recognition. Besides, Graphical User Interface is developed for better user experience. The software is developed in the Visual C++ environment and the image processing is done by the OpenCV library. With the 100 images that being tested, the success rate for the car plate image extraction is 94%, segmentation is 93% while recognition is 75%. This recognition system does not give high recognition accuracy but improvement is suggested on the software development such as adaptive threshold mechanism and chain code normalization prior to recognition phase.
ABSTRAK

# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td></td>
<td>ii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td></td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td></td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td></td>
<td>v</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td></td>
<td>vi</td>
</tr>
<tr>
<td>TABLE OF CONTENT</td>
<td></td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td></td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td></td>
<td>xiii</td>
</tr>
</tbody>
</table>

## 1 PROJECT OVERVIEW

1.1 Project Background  1
1.2 Problem Statement  2
1.3 Objectives  2
1.4 Scope of Study  3

## 2 LITERATURE REVIEW

2.1 Car Plate Recognition System  4
2.2 Algorithm for Car Plate Recognition System  5
  2.2.1 Plate localization  5
  2.2.2 Plate orientation and sizing  5
  2.2.3 Image Normalization  6
  2.2.4 Character segmentation  6
  2.2.5 Optical character recognition.  6
  2.2.6 Syntactical/Geometrical analysis  7
2.3 Key challenges of Car Plate Recognition system 8
2.4 Existing OCR Technique 10
  2.4.1 Neural Network 10
  2.4.2 Template Matching 11
  2.4.3 Stroke Analysis 12
  2.4.4 DSP based Recognition Algorithm 13
  2.4.5 Hausdorff Distance 14
2.5 Chain Code 15
2.6 OpenCV 17

3 METHODOLOGY 19
  3.1 Overall Project Methodology 19
  3.2 Image Pre-Processing 20
  3.3 Car Plate Image Extraction 20
  3.4 Character Segmentation 21
  3.5 Chain Code Derivation 22
    3.5.1 Database Creation 23
    3.5.2 Local Signature 24
  3.6 Character Recognition 26

4 SOFTWARE DEVELOPMENT 27
  4.1 Pre-Processing Phase 27
  4.2 Car Plate Image Extraction 28
  4.3 Character Segmentation 29
  4.4 Character Database Creation 30
  4.5 Character Recognition 31
  4.6 Graphical User Interface Design 32

5 RESULT 33
  5.1 Local Signature (Feature) Extraction 33
  5.2 Car Plate Recognition System Results 36
  5.3 Graphical User Interface Result 39
  5.4 Recognition Result 40
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5 Discussions</td>
<td>42</td>
</tr>
<tr>
<td>6 CONCLUSION</td>
<td>43</td>
</tr>
<tr>
<td>6.1 Conclusion</td>
<td>43</td>
</tr>
<tr>
<td>6.2 Future Work and Suggestion</td>
<td>44</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>45</td>
</tr>
<tr>
<td>Appendices A-B</td>
<td>47-67</td>
</tr>
</tbody>
</table>
### LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Crop Area Minimum and Maximum Database</td>
<td>34</td>
</tr>
<tr>
<td>5.2</td>
<td>Character Size, Upper and Lower Row Length Minimum and Maximum Database</td>
<td>35</td>
</tr>
<tr>
<td>5.3</td>
<td>Car Plate Recognition System Accuracy Rate</td>
<td>40</td>
</tr>
<tr>
<td>5.4</td>
<td>Accuracy Rate of the Numbers Recognized Successfully</td>
<td>41</td>
</tr>
<tr>
<td>5.5</td>
<td>Accuracy Rate of the Characters Recognized Successfully</td>
<td>41</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Low spatial resolution</td>
<td>9</td>
</tr>
<tr>
<td>2.2</td>
<td>Blurred image</td>
<td>9</td>
</tr>
<tr>
<td>2.3</td>
<td>Low contrast</td>
<td>9</td>
</tr>
<tr>
<td>2.4</td>
<td>Overexposure</td>
<td>9</td>
</tr>
<tr>
<td>2.5</td>
<td>Bad lightning conditions</td>
<td>9</td>
</tr>
<tr>
<td>2.6</td>
<td>High distortion</td>
<td>9</td>
</tr>
<tr>
<td>2.7</td>
<td>Input character features</td>
<td>13</td>
</tr>
<tr>
<td>2.8</td>
<td>4-directional neighborhoods</td>
<td>15</td>
</tr>
<tr>
<td>2.9</td>
<td>8-directional neighborhoods</td>
<td>16</td>
</tr>
<tr>
<td>2.10</td>
<td>Direction and number assign of the shape</td>
<td>17</td>
</tr>
<tr>
<td>2.11</td>
<td>The Basic Structure of OpenCV</td>
<td>18</td>
</tr>
<tr>
<td>3.1</td>
<td>Block Diagram for Car Plate Recognition System</td>
<td>19</td>
</tr>
<tr>
<td>3.2</td>
<td>Bounded Area Point, Width and Height Representation</td>
<td>21</td>
</tr>
<tr>
<td>3.3</td>
<td>Crop Area for Character</td>
<td>25</td>
</tr>
</tbody>
</table>
3.4 Upper and Lower Row Length for Character

3.5 Height and Width for Character

4.1 Pre-Processing Process Flow

4.2 Car Plate Image Extraction Process Flow

4.3 Character Segmentation Process Flow

4.4 Characters Database Derivation

4.5 Chain Code Derivation

4.6 Character Recognition Process Flow

5.1 Original Image

5.2 Pre-Processed Image

5.3 Blob Detected Image

5.4 Extracted Car Plate Image

5.5 Segmented Image

5.6 Overall Car Plate Recognition System Result

5.7 Overall Car Plate Recognition System Result with high contrast image

5.8 Overall Car Plate Recognition System Result with dark image

5.9 Overall Car Plate Recognition System Result with complicated car plate region image

5.10 Graphical User Interface for the Car Plate Recognition System
<table>
<thead>
<tr>
<th>APPENDICES NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Characters Database</td>
<td>47</td>
</tr>
<tr>
<td>B</td>
<td>Characters Extra Feature Database</td>
<td>49</td>
</tr>
</tbody>
</table>
1.1 Project Background

Car plate recognition system is a complex image processing application which recognizes the characters on a car plate based on the given conditions and instructions. The car plate recognition system is also known as automatic number plate recognition, automatic vehicle identification, car plate reader or optical character recognition for cars. In short, typical car plate recognition involves 4 general processes: captures, interprets, records, process image.

Car plate recognition system has wide variety of applications. It is used as the vehicle access control, state border control, traffic surveillance, vehicle traffic monitoring. Car plate recognition system is getting more and more important nowadays because it is used for the law enforcement where it could detect the speeding vehicles. Besides, this system helps to improve the security in the resident area or parking space where all vehicles are well monitored every moment. Car plate recognition system also eliminates the need of the parking tickets in the department store or the ticket for the highway where the vehicle owner can just pay the toll charges by scanning the vehicle car plate and it able to catch those who never pay. In this case, long queue for toll charges payment and traffic jam during peak hour can be avoided.
1.2 Problem Statement

Nowadays, different vendors develop different types of car plate recognition system where each of the car plate system using different recognition method to achieve the target. However, each of the existing system has their own weaknesses. The weaknesses of the existing car plate recognition system are slow computation time, low accuracy and extremely high cost.

Besides, most of the image processing tools in the market currently are using Matlab as the software development interface. For image processing, the biggest challenge when developing the software is on the speed and efficiency. For speed, Matlab is slower comparable than C++ environment as Matlab is a language which converts from C to Java, followed by Matlab. Hence, it takes longer computation time. On the efficiency, Matlab utilize big resource compared to C++ environment which only need to consider the memory management.

1.3 Objectives

The objectives of this project are:

i. Development of the offline car plate recognition system which able to recognize the standard car plate in Malaysia

ii. To identify the local signature of each of the alphabet and numbers and create the database for the alphabet and numbers of the car plate.

iii. To identify characters on the car plate based on chain code and the local signature

iv. To develop a GUI using the Microsoft Visual C++ and Open CV library for image processing and decode
1.4 Scope of Project

This project involves a series of research work on developing the offline system for car plate recognition system which can be categorized as below:

i. To understand the car plate recognition system phases which normally consists of the plate localization, character segmentation and optical character recognition.

ii. To study on the Freeman Chain Code algorithm and weaknesses and to explore the local signature of the alphabets and numbers on the car plate.

iii. To explore on the way to develop graphical unit interface for the recognition system.
REFERENCES


5. Anoop Sehgal A/L Paras Ram *Design of a recognition system for special Malaysian car plates using stroke analysis*. Thesis. University Technology Malaysia; April 2005


