IMAGE PROCESSING BASED VEHICLE'S LICENSE PLATE TRACKING AND RECOGNITION SYSTEM

LORITA ANGELINE



SCHOOL OF ENGINEERING AND INFORMATION TECHNOLOGY UNIVERSITI MALAYSIA SABAH 2013

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LORITA ANGELINE

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CERTIFICATION

- NAME : LORITA ANGELINE
- MATRIC NO. : **PK2008-8354**
- TITLE: IMAGE PROCESSING BASED VEHICLE'S LICENSE PLATE
TRACKING AND RECOGNITION SYSTEM
- DEGREE : MASTER OF ENGINEERING (ELECTRICAL AND ELECTRONIC ENGINEERING)
- VIVA DATE : 5 FEBRUARY 2013



DECLARED BY

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ABSTRACT

IMAGE PROCESSING BASED VEHICLE'S LICENSE PLATE TRACKING AND RECOGNITION SYSTEM

The main objective of this research is to design and develop an automatic license plate localisation and recognition system for vehicle in real street scene with constraints on extrinsic imaging parameters such as pose, illumination, scale, position and varying angles. As the number of applications such as the surveillance system for license plate recognition system increase, there is a need for an accurate system that can be applied to dynamic vehicles in the real street scene. However, one major difficulty in object detection is the fact that different views of the same object can look very different, as an image is essentially the projection of a 3D object onto a 2D plane. The presence of an extraneous moving vehicle's license plate in the system's field of view also may affect the processing results. Therefore, a new algorithm for automatic license plate localisation and recognition (ALPR) is proposed on the basis of Signature Analysis and Isotropic Dilation (SAICCA). The localised license plate region is further processed and the characters are segmented into individual character. Properties obtained from the Signature Analysis such as ratio of the character and features extracted from the segmented character is fed and trained in a multi-layer feed-forward back-propagation neural network. Designing and developing of the ALPR system is programmed in MATLAB m-file. Evaluations and assessments have been carried out and observational results show an improvement of 32% in license plate localisation by using Signature Analysis and the improved Connected Component Analysis (SAICCA) compared to the conventional Connected Component Analysis (CCA).

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ABSTRAK

Objektif utama kajian ini adalah untuk merekabentuk dan membangunkan sistem pengesan dan mengenalpasti plat lesen untuk kenderaan di jalan raya dengan kekangan lanjut dari segi parameter pengimejan ekstrinsik seperti pencahayaan, skala, kedudukan dan penggunaan sudut yang berbeza. Peningkatan penggunaan aplikasi mengenalpasti plat lesen seperti sistem pengawasan telah menjurus kepada satu keperluan untuk suatu sistem yang tepat dan sesuai digunakan untuk kenderaan dinamik di jalan raya. Walau bagaimanapun, salah satu kesukaran utama dalam pengesanan objek adalah bahawa pandangan pada sudut yang berbeza ke atas satu objek yang sama boleh kelihatan sangat berbeza. Perkara ini berlaku kerana, secara asasnya imej adalah unjuran objek 3D ke atas satah 2D. Di samping itu, kehadiran plat lesen kenderaan asing yang bergerak di dalam sudut pemerhatian boleh mempengaruhi keputusan pemprosesan. Justeru, satu algoritma baru yang berasaskan "Signature Analysis" dan "Isotropic Dilation" dicadangkan untuk mengesan dan mengenalpasti plat lesen kenderaan secara automatik (ALPR). Plat lesen yang berjaya dikesan akan diproses supaya setiap huruf dan nombor diasingkan. Nilai-nilai kuantitatif yang diperolehi dari teknik "Signature Analysis", seperti nisbah bagi setiap huruf/nombor dan ciri-ciri yang diekstrak dari huruf/nombor dilatih di dalam "multi-layer feed-forward back-propagation neural network". Pembangunan sistem ALPR ini adalah diprogram dengan menggunakan MATLAB m-fail. Penilaian telah dijalankan dan hasil pemerhatian menunjukkan bahawa penggunaan "Signature Analysis" dan "Isotropic Dilation" (SAICCA) di dalam sistem ini mempunyai peningkatan sebanyak 32% dalam mengesan dan mengenalpasti plat lesen untuk kenderaan di jalan raya.



TABLE OF CONTENTS

TITLE	i
DECLARATION	ii
CERTIFICATION	iii
ACKNOWLEDGMENT	iv
ABSTRACT	v
ABSTRAK	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	x
LIST OF FIGURES	xii
LIST OF ABBREVIATIONS	xvi
LIST OF NOMENCLATURE	xviii
CHAPTER 1: INTRODUCTION 1.1 General Overview 1.2 Overall System 1.3 Problem Statement 1.4 Scope of Work 1.5 Research Aim 1.6 Thesis Outline	1 2 3 4 5
CHAPTER 2: REVIEW OF LICENSE PLATE LOCALISATION AND	6
 2.1 An Overview of Automatic License Plate Recognition (ALPR) System 2.2 License Plate Localisation 2.2.1 Edge Detection 2.2.2 Identification of the Yellow Region As a License Plate 2.2.3 License Plate Localisation Using Novel Texture Descriptor 2.2.4 Smearing Algorithm 2.2.5 Literature Comparison of License Plate Localisation Algorithms 2.3 License Plate Character Segmentation 2.3.1 Vertical and Horizontal Projection 2.3.2 The Improved Vertical Projection 2.3.4 Horizontal Scan Line and Clustering Approach 	6 7 12 13 14 15 17 17 20 21
2.3.3 Connected Component Analysis	22

	2.3.5	Literature Comparison of License Plate Segmentation	22
2.4	Licens	e Plate Character Recognition	23
	2.4.1	DSP Based Real-time Character	24
	2.4.2	Stroke Analysis	25
	2.4.3	Template Matching	27
	2.4.4	Gabor Filter	28
	2.4.5	Artificial Intelligence Approaches	28
	2.4.6	Literature Comparison of License Plate Recognition Algorithms	29
2.5	Chapte	er Summary	31
СНА	PTER 3	3: OVERVIEW OF IMAGE PROCESSING TECHNIQUES	32
3.1	Introd	uction	32
3.2	Image	Pre-processing	33
	3.2.1	Image Colour Conversion	33
	3.2.2	Motion Detection	33
	3.2.3	Image Noise Reduction	34
	3.2.4	Connected Component Analysis	35
3.3	Detect	ting License Plate Candidate	39
	3.3.1	Localisation of Vehicle's License Plate via Signature Analysis	39
	3.3.2	Performance Analysis of Kwasnicka and Wawrzyniak's System	41
3.4	Chara	cter Recognition via Neural Network	42
	3.4.1	Thinning Algorithm	44
	3.4.2	Thinning Algorithm - Deletion Point	46
Þ	3.4.3	Thinning Algorithm - Contour Point	48
Z	3.4. <mark>4</mark>	Universe of Discourse	49
3.5	Chapte	er Summary	51
СНА	PTER 4	4: DEVELOPMENT OF THE VEHICLE LICENSE PLATE	52
	~4	TRACKING AND RECOGNITION SYSTEM A SADAR	
4.1	Introd		52
4.2	Vehicle	e's License Plate Localisation	54
	4.2.1	Motion Detection with Pre-processing	54
	4.2.2	Detecting License Plate via Signature Analysis	5/
4.3	Licens	e Plate Segmentation	62
4.4	Licens	Se Plate Character Recognition	63
	4.4.1	Extracting Character's 5 x / Real Values	63
4 5	4.4.2	Character Recognition by Using Neural Network	64
4.5	Chapte	er Summary	60
CHA	PTER !	5: SYSTEM ENHANCEMENT FOR TRACKING IN THE NON-	68
51	Introd		60
5.1	Dotod	ucului ting and Decognicing the Occurrence of Extra Vehicle	00 71
5. Z		Detecting Non unique Rounding Poyes	/1
	5.2.1 5 7 7	Detecting Non-Unique Dounding DOXES	/1 72
5 2	J.Z.Z Enhan	coment of Signature Analysis	73
5.5		Classification of Signature Degion by Using Isotronic Dilation	/) 75
	2.2.1	Classification of Signature Region by Using Isotropic Dildtion	73 76
	5.5.2	Signature Analysis with Adaptive Sediciling	70

5.4	Character Recognition by Using Features Extraction 5.4.1 Intersection Point	78 78
	5.4.2 Minor Starters	79
	5.4.3 Type of Line	82
5.5	Chapter Summary	85
CHA	APTER 6: PERFORMANCE ANALYSIS OF THE DEVELOPED	86
6.1	Introduction	86
6.2	Overcome Difficulties in a Non-ideal Environment	87
	6.2.1 Occurrence of Extra Vehicle	87
	6.2.2 Overlapping of Vehicles	91
	6.2.3 Recognising Non-ideal Characters	94
6.3	Evaluation of Unsuccessful Results	100
	6.3.1 Low Illumination	100
	6.3.2 Shadow Effect	101
6 1	6.3.3 Distorted Characters	101
0.4	Evaluation of Successful Results	102
	6.4.2 Distinguishing Two Moving Vehicles	110
	6.4.3 Distinguishing Overlapping Vehicles	113
	6.4.4 System Performance Analysis	114
6.5	Chapter Summary	115
CHA	APTE <mark>R 7: CON</mark> CLUSION	116
7.1	Summary	116
7.2	Achievements	118
/.3	Future Works	118
REF	ERENCES UNIVERSITI MALAYSIA SABAH	120
APP	PENDIX A: MATLAB CODE – FUNCTION TO TRACK VEHICLE IN MOTION	125
APP	PENDIX B: MATLAB CODE – SIGNATURE ANALYSIS	128
APP	PENDIX C: MATLAB CODE – FUNCTION TO DISTINGUISH TWO MOVING VEHICLES	130
APP	PENDIX D: MATLAB CODE – FUNCTION TO DETERMINE	131
APP	PENDIX E: MATLAB CODE – FUNCTION TO LOCATE LICENSE	134
	PLATE CANDIDATE WITH ADAPTIVE SEAKCHING	
APP	PENDIX F: MATLAB CODE – CREATING AND TRAINING THE NEURAL NETWORK	135
APP	PENDIX G: LIST OF PUBLICATIONS	136

LIST OF TABLES

Table 2.1	Yellow colour range in the RGB space	13
Table 2.2	Literature comparison of various types of license plate localisation algorithms	16
Table 2.3	Horizontal segmentation using Hough Transform	18
Table 2.4	Vertical segmentation algorithm	19
Table 2.5	Literature comparison of various types of license plate character segmentation algorithms	23
Table 2.6	Literature comparison of various types of license plate recognition algorithms	30
Table 3.1	Performance evaluation of system designed by Kwasnicka and Wawrzyniak	41
Table 3.2	Condition G1 checking at point-A	47
Table 3.3	Condition G2 checking at point-A	47
Table 3.4	Condition G2 checking at point-B	48
Table 4.1	Camera's setting and observational setup AYSIA SABAH	52
Table 4.2	Procedure of vehicle localisation	56
Table 4.3	Parameter set for Signature Analysis	58
Table 4.4	Parameter set for Neural Network architecture	65
Table 5.1	System enhancement	69
Table 5.2	Rules to determine type of line	83
Table 5.3	Parameter set for the re-designed Neural Network architecture	83
Table 6.1	Evaluation of the proposed system	86
Table 6.2	Evaluation of the character recognition system	95
Table 6.3	Tests of variety driving motion	102

- Table 6.4Analysis of conventional Connected Component Analysis and114the improved Connected Component Analysis
- Table 6.5Performance analysis of the developed system114



LIST OF FIGURES

Figure 2.1	Elements in ALPR system	6
Figure 2.2	Example of Roberts' Cross mask	8
Figure 2.3	Example of Prewitt Mask	9
Figure 2.4	Example of Sobel Operator	10
Figure 2.5	Illustration of vertical edge projection	11
Figure 2.6	Example of Horizontal Density Vector	11
Figure 2.7	Implementation of Sobel Operator approach on frameless license plate	14
Figure 2.8	Implementation of smearing algorithm on frameless license plate	15
Figure 2.9	Horizontal segmentation results	18
Figure 2. <mark>10</mark>	The valley cut between two mountain peaks	19
Figure 2.11	Types of Vietnamese license plate	20
Figure 2.12	Illustration of clustering algorithm	21
Figure 2.13	Segmentation of Malaysian license plate	22
Figure 2.14	Illustration of Stroke Analysis	25
Figure 2.15	Illustration of scanning priority	26
Figure 3.1	Image colour conversion	33
Figure 3.2	Localised moving vehicle by using background subtraction	34
Figure 3.3	Image noise reduction by using median filter	35
Figure 3.4	Sample of input image with extracted license plate	35
Figure 3.5	Extracted license plate represented in simple matrix	36
Figure 3.6	Notion of connectivity	37
Figure 3.7	Identified characters from the license plate	38

Figure 3.8	Assigning label ID to connected components	38
Figure 3.9	Localisation of license plate in an image	40
Figure 3.10	'Signature' of a license plate	41
Figure 3.11	Diagram of 4-layer perceptron with two hidden layers	42
Figure 3.12	Illustration of neural network for character recognition	43
Figure 3.13	8-neighbours relationship	44
Figure 3.14	Thinning of character 'T'	46
Figure 3.15	Character 'T' in 8-neighbours relationship (point-A)	46
Figure 3.16	Character 'T' in 8-neighbours relationship (point-B)	48
Figure 3.17	Finding the shortest matrix for the character skeleton	49
Figure 3.18	Finding uppermost and lowermost pixels in y-direction	50
Figure 3.19	Finding leftmost and rightmost pixels in <i>x</i> -direction	50
Figure 4.1	Development of vehicle's license plate tracking and recognition system	53
Figure 4.2	Vehicle motion detection and pre-processing	55
Figure 4.3	Vehicle localisation by using Connected Component Analysis	57
Figure 4.4	Scanning results using Signature Analysis	58
Figure 4.5	Procedure of Signature Analysis	59
Figure 4.6	Evaluation of Signature Analysis	60
Figure 4.7	Samples of generated signature	61
Figure 4.8	Imperfect license plate characters	63
Figure 4.9	Character thinning and resizing	64
Figure 4.10	Training in Neural Network	65
Figure 4.11	Samples of recognised characters	66
Figure 5.1	Development of the enhanced system	70

Figure 5.2	Evaluation of conventional CCA	71
Figure 5.3	Multiple bounding boxes detected by using conventional CCA	72
Figure 5.4	Performing isotropic dilation on case 1 and case 2	73
Figure 5.5	Example of bounding boxes	74
Figure 5.6	Example of overlapping edges	74
Figure 5.7	Evaluating pixels contribution (shared)	75
Figure 5.8	Multiple bounding boxes detected in the license plate region	75
Figure 5.9	Classification of license plate region	76
Figure 5.10	Adaptive searching procedure	77
Figure 5.11	Illustration of adaptive searching	77
Figure 5.12	Pixel with three neighbours	78
Figure 5.13	Pixel with four neighbours	79
Figure 5.14	Pixel with five or more neighbours	79
Figure 5.15	Initial skeleton before character traversal	80
Figure 5.16	Extracting line segments	81
Figure 5.17	Determining direction vector	82
Figure 5.18	Finding new line segment in a 'v'	83
Figure 5.19	Line classification in each zone of the thinned character	84
Figure 6.1	Sample of two moving vehicles	87
Figure 6.2	Conventional Connected Component Analysis	88
Figure 6.3	Isotropic dilation thresholding	89
Figure 6.4	Eliminating padded pixels (fat clumps)	89
Figure 6.5	Isotropic Dilation with Connected Component Analysis	90
Figure 6.6	Sample of overlapping vehicles	91
Figure 6.7	Overlapping vehicles analysis	92

Figure 6.8	Processing overlapping vehicles by using conventional Connected Component Analysis	92
Figure 6.9	Searching for pixels shared by overlapped bounding boxes	93
Figure 6.10	Analysis of the refined bounding box properties	93
Figure 6.11	Sample of license plate to be tested	95
Figure 6.12	Results of the Test 1, Test 2 and Test 3 performed on the designed Neural Network with 5 \times 7 real values as input	96
Figure 6.13	Results of the Test 1, Test 2 and Test 3 performed on the designed Neural Network with 56-element input vector	98
Figure 6.14	Unsuccessful result - Low illumination	100
Figure 6.15	Unsuccessful result - Shadow effect	101
Figure 6.16	Unsuccessful result - Distorted characters	101
Figure 6.17	Sample input of vehicle in motion (frontal view)	103
Figure 6.18	Sample input of vehicle in motion (rear view)	103
Figure 6.19	Sample input of vehicle in motion (image from a distance)	104
Figure 6.20	Sample input of vehicle in motion (illumination change)	104
Figure 6.21	Test 1(A) - Driving forward	106
Figure 6.22	Test 1(B) - Driving away	107
Figure 6.23	Test 1(C) - Inclination	108
Figure 6.24	Test 1(D) - Vehicle making a turn	109
Figure 6.25	Test 2 - Distinguishing two moving vehicles	111
Figure 6.26	Test 2 - Distinguishing two moving vehicles and recognising its license plate	112
Figure 6.27	Test 3 – Distinguishing overlapping of vehicles	113

LIST OF ABBREVIATION

- **2-D** Two Dimension
- **3-D** Three Dimension
- ASCII American Standard Code for Information Interchange
- ALPR Automatic License Plate Recognition
- CCA Connected Component Analysis
- CPU Central Processing Unit
- **DSP** Digital Signal Processing
- **fps** Frame per second
- GA Genetic Algorithm
- HDV Horizontal Density Vector
- **ICCA** Improved Connected Component Analysis
- ICHT Improved Connective Hough Transform
- ILLIAC Illinois Automatic Computer
- ITS Intelligent Transportation System MALAYSIA SABAH
- MLP Multi Layer Perceptron
- ms Millisecond
- NN Neural Network
- NTSC National Television System Committee
- **OCR** Optical Character Recognition
- PC Personal Computer
- PE Processing Element
- RGB Red Green Blue
- ROI Region of Interest

- **SA** Signature Analysis
- **SAICCA** Signature Analysis with Improved Connected Component Analysis
- **SVM** Support Vector Machine
- **UOD** Universe of Discourse
- **WH** Width-to-height ratio



LIST OF NOMENCLATURE

++	Increment by 1
V	Logical OR
٨	Logical AND
Σ	Summation sign
(x,y)	Pixel's coordinate
С	Centre pixel
cur_col	Current column
cur_row	Current row
<i>cz</i> 1	Column zone 1 of a given character
cz2	Column zone 2 of a given character
cz3	Column zone 3 of a given character
E.0	End of
G1	Hilditch first condition
G3	Hilditch second condition RSITI MALAYSIA SABA
G3	Hilditch third condition
height _{bm}	Blob height
h _{cn}	Cluster height
maxY _{bm}	Maximum Y value of a blob
maxY _{cn}	Maximum Y value in the cluster
min	Minimum value
p	Pixel under consideration
rz1	Row zone 1 of a given character
rz2	Row zone 2 of a given character

- *rz*1 Row zone 3 of a given character
- r_{1x} Radius of bounding box 1 in the x-direction
- r_{2x} Radius of bounding box 2 in the x-direction
- r_{12x} Radius from the centre of bounding box 1 to bounding box 2 in the x-direction
- r_{1y} Radius of bounding box 1 in the y-direction
- r_{2y} Radius of bounding box 2 in the y-direction
- r_{12y} Radius from the centre of bounding box 1 to bounding box 2 in the y-direction
- R_X Radius from the centre point to the edge in the x-direction
- R_y Radius from the centre point to the edge in the Y-direction

x

Neighbour of the pixel under consideration



CHAPTER 1

INTRODUCTION

1.1 General Overview

Initially, all digital images of vehicles license plate were interpreted by human. However, much technology that was developed in the 1940s until 1990s has found its way into the photo-enforcement industry. Computer based plate recognition went out in the 1980's. In 1993, the technology made a successful changeover from the research bench to the commercial marketplace. Lately, as supply and dynamics demand took control, off-the-peg technology began accessible from a greater number of suppliers. Nowadays, with over three dozen suppliers offering commercial plate recognition technology, the technology is finding its way into solutions-oriented Intelligent Transportation System (ITS).

Every vehicle will carry a unique license plate and there are no external cards, tags or transmitter need to be recognized (Ozbay and Ercelebi, 2005). For some applications, such as electronic toll collection and red-light violation enforcement, Automatic License Plate Recognition (ALPR) system localises and identifies vehicles by reading their alphanumeric license plate so that the vehicle owner can be assessed with the appropriate toll or fine. ALPR systems have been physically utilised in many facilities such as parking lots, security control of restricted areas and traffic surveillance. Furthermore, the rise of security awareness has made the demand for vehicle based authentication technologies extremely significant. Regardless of the fact that the license plate can be intentionally altered in fraud situations, license plate yet remains as the primary vehicle identifier. Therefore, ITS rely to a great extent on a robust ALPR systems. Due to the various types of license plate being used, the necessity of an ALPR system is rather different for each country. The Road Transport Department of Malaysia has endorsed a specification for vehicle's license plate that includes the font and size. In Malaysia, there are more than ten different forms that have minor or major differences between them (Al Faqheri and Mashohor, 2009).

1.2 Overall System

ALPR system is a kind of ITS technology that not only recognizes and counts vehicles, but distinguishes each as unique. A typical ALPR system is constituted of a video image-acquisition subsystem, a central processing unit for image processing and control, hardware or software based character recognition engine, and a database or transmission subsystem for electronically reading data such as date, time and license plate. Whereas, the system's flow of process can be categorized into three main steps: license plate location, character segmentation, and character recognition (Jia *et al.*, 2007).

As a vehicle gets in a system's operative field, it activates a composite processing cascade. Vehicle's presence can be detected by an external trigger, such as sensor, trip wire, in-ground loop, or cross-traffic light beam, or an internal trigger. Wherein, the signal changes from the video subsystem alerts the processor that an object of interest may be present. The video camera then captures an image or series of images of the passing vehicle.

Once the image is digitized, the next task is to determine the location of the license plate. The system needs to search for the license plate among a sea of similar objects such as bumper stickers, fleet identification numbers, manufacturer's labels, dealer logos and parking permits. Normally, several tests will be performed to isolate and confirm that a valid license plate candidate is present and then submit for next processing stage.

Upon the successful of character recognition, the peculiar manner of lettering and syntax can assist in fine-tuning the decision. Syntax pertains to the number and positioning of characters on the plate, its sequence, and whether each can be a letter, number or other character. The successful interpreted data can then be held for query against an established database or sent to another file server for further processing or storage. If the system is being utilized for enforcement, the data may be archived and used as evidence later. The external effects such as sun and headlights, distorted plates, various types of license plate and the limited level of the recognition software and vision hardware yielded low quality systems. Thus, a large numbers of scholars and researchers were attracted to develop algorithms and techniques to enhance and diversify this field of research. Nowadays, the car plate recognition systems are much more reliable and wide spread with the recent improvements in the software and hardware facilities. It can be found in numerous facilities and the number of systems is growing exponentially, effectively automating more and more tasks in different market segments.

1.3 Problem Statement

Due to a huge number of vehicles increased rapidly since the 1960s, the chances of having the identical vehicle model with exact colour at the same place are extensively high. As there are so many cases involving vehicle such as vehicle theft, hit and run, carjacking and other crime involving vehicles, it is very important to identify each vehicle uniquely. Each and every vehicle will carry a unique license plate and there are no external cards, tags or transmitter need to be recognised (Ozbay and Ercelebi, 2005). Thus license plates still remains the primary vehicle identifier and image processing based algorithm is practicable to develop an ALPR system.

However, vehicle has to be motionless in order for its license plate to be recognised. Hence there is a high demand in tracking dynamic vehicle's license plate. ALPR is a form of image processing based technology used to identify vehicles by only their license plate. However the current research in ALPR is concentrated on the static image. Detecting and identifying moving vehicle on the street is considerable more difficult than detecting and identifying the entire vehicle in a static image. Thus, there is a need for an accurate system that can be applied to dynamic vehicle in the real street scene.

1.4 Scope of Work

Detecting and identifying vehicles in the street scenes is considerably more difficult than detecting and identifying a vehicle in a static image. The presence of a second