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

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I hereby declare that the work in this dissertation is my own except for quotations, equations, summaries and references, which I have duly acknowledged.

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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).

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.

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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
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
$\vee$	Logical OR
$\wedge$	Logical AND
$\sum$	Summation sign
(x, y)	Pixel's coordinate
C	Centre pixel
cur_col	Current column
cur_row	Current row
$cz1$	Column zone 1 of a given character
$cz2$	Column zone 2 of a given character
$cz3$	Column zone 3 of a given character
$E.O$	End of
$G1$	Hilditch first condition
$G3$	Hilditch second condition
$G3$	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

$rz1$	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