VEHICLE TYPE CLASSIFICATION BASED ON FRONTAL PROFILE

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Dedicated with love and thankfulness to

Amma, Appa, Kala, Mani, Patties.

To all family members,

Thanks for being there during our hardest times.

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ABSTRACT

Vehicle recognition and classification is useful to many traffic management activities and is one of the important technologies in Intelligent Transportation System (ITS). Automatic toll collection, vehicle access control, traffic forecast and volume, congestion management and speed monitoring are some of the systems that have a need to classify the vehicle types. This project highlights the potential use of vehicle dimensions and shape information for the vehicle type classification. The system profiles the frontal view of the vehicles and extracts the basic outline shapes and geometrical parameters and compares against the stored specification for each class. The design utilizes Hough line detection algorithm to identify the location of vehicle properties that needs to be extracted. Input to the system is a static image of vehicle frontal view. The image is processed through various image processing methods namely; median filtering, morphological reconstruction, edge detection and Hough transform. Finally, the designed system is able to determine and classify various vehicle types into three major classes; car, bus and truck. This design is a useful support system to existing Plate Number Recognition System (PNRS) which will help to increase the accuracy of the results obtained.

ABSTRAK

Mengklasifikasi kenderaan amat berguna dalam kerja-kerja pengurusan trafik dan ianya adalah salah satu teknologi penting dalam Sistem Pengangkutan Pintar (ITS). Kutipan tol automatik, kawalan akses kenderaan, ramalan dan pengurusan trafik dan kesesakan, dan pemantauan kelajuan adalah conthoh aplikasi yang mempunyai keperluan untuk mengklasifikasi jenis kenderaan. Projek ini merealisasikan penggunaan dimensi dan bentuk kenderaan untuk mengklasifikasikan jenis kenderaan. Sistem ini memprofil pandangan hadapan kenderaan, dimana parameter geometri dan bentuk asas kenderaan diekstrak untuk dibandingkan denagan spefikasi bagi setiap kelas. “Hough transform” diaplikasikan untuk mengenal pasti lokasi setiap paramter yang perlu diekstrak daripada imej kenderaan. Selain itu, pelbagai kaedah pemprosesan imej yang lain juga digunakan dalam usaha mengekstrak parameter geometri kenderaan. Sistem yang direka ini, mampu mengenal pasti dan mengklasifikasi pelbagai jenis imej kenderaan kepada tiga kelas utama; kereta, bas dan trak. Reka bentuk ini boleh digunakan sebagai sistem sokongan kepada sistem pengenalan nombor plat (PNRS).

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LIST OF ABBREVIATIONS

ITS	-	Intelligent Transportation System
MHWR	-	Maximum Height – Width Ratio
PNRS	-	Plate Number Recognition System
PDF	-	Probability Density Function
TBWR	-	Top-Bottom Width Ratio
WOHR	-	Windscreen-Overall Height Ratio

LIST OF SYMBOLS

M_x , M_y	-	Edge operator mask
S, s	-	Similarity percentage
$\hat{f}(x, y)$	-	Median Filter Function
$f(a)$	-	Normal Probability Density Function (PDF)
θ	-	Angle between positive x-axis and the perpendicular projection from the origin to the measured line in Hough Transform
μ	-	Mean value
σ	-	Standard Deviation
ρ	-	Distance from origin to a line along a vector perpendicular to the line in Hough Transform

CHAPTER 1

INTRODUCTION

This project proposes the development of a software tool to determine and classify vehicle type from its frontal profile. The software can be applied in the traffic control and monitoring systems for the vehicle type recognition. In the first chapter, the background of this project is discussed, providing the objective and scope of the work.

1.1 Project Background

Vehicle type classification is one of the core technology applications in the Intelligent Transportation System (ITS). ITS corresponds to the technology applied in road infrastructure in order to improve the safety and efficiency of transportation. Many countries have been involved in various researches in this field to overcome the primary transportation issues. Malaysia has also developed the traffic management system which includes incident detection and vehicle location system that have been implemented in some of the main traffic roadways.

Vehicle recognition and classification is useful to many traffic management activities. Automatic toll collection, vehicle access control, traffic forecast and volume, congestion management and speed monitoring are some of the systems that have a need to classify the vehicle types. These systems are designed for the purpose of security, safety and reliability of transportation and vehicle classification is one of the major components of these systems.

Vehicle type classification system can be grouped into two categories, the sensor based system and the camera based system. The sensor based system involves installation of inductive loop magnetic detectors onto the roadways. Information on vehicle counts, distance between vehicles and the vehicle weights can be obtained by analyzing the signal generated by the sensor. Applying sensor approach for vehicle classification can be costly and sometimes the accuracy level is low. Road congestion and high speed vehicle may cause inaccurate classification depending on the sensitivity of the sensors. Besides, this system will be interrupted during the road construction activities as the sensors are implanted onto the roads.

On the other hand, video camera based recognition systems are classified as nonintrusive methods as there is no need for direct injection of any component onto the road. Traffic cameras will be fixed on top of the roadways and the system will not be disrupted during road construction works. The camera based vehicle classification systems apply various image processing techniques in order to detect and recognize the vehicle class.

This project highlights the potential use of vehicle dimensions and shape information for the vehicle classification. In such a system, captured images will be processed through few phases before the final shape and dimension can be extracted. Accuracy of the extracted features is very vital for proper classification of vehicle type. Hence, the applied image processing techniques will be one of the major contributors to the accuracy of the system.

1.2 Objective

The project aims to design a vehicle type classification system based on the frontal profile of the vehicle images. Classification is to be done, based on the differences in the geometrical properties between the vehicle groups.

1.3 The Motivation

Accurate vehicle classification system is an important element in the measure of enhancing road safety and transportation reliability. By integrating this system to existing plate number recognition systems (PNRS) will further increase the accuracy and the validity of the results obtained.

In some situations, PNRS may fail in providing the correct information due to unsatisfactory image quality or falsified number plates. Such cases highlight the need of a support system to increase the robustness of authentication. Vehicle type classification can be applied as one of the support system to cross match the number plate against the vehicle class which will directly help to increase the accuracy of the system and indirectly prevent car theft, insurance frauds or other criminal activities.

The motivation behind this choice of developing a vehicle type classification tool is to provide the traffic management and control systems with useful software that can be applied in various ITS projects. The aim is to improve the safety and security of transportation. Furthermore, the PNRS developers should be encouraged by the evidence presented in this project in order to incorporate this system in their new designs. In the same way, the users should be convinced with the obtained

results through a design that combines PNRS and the vehicle type classification system.

1.4 Scope of the Project

In this project 3 types of vehicle classification will be considered. They are:

- CLASS 1: CAR
- CLASS 2: BUS
- CLASS 3: TRUCK

The project involves only software implementation in which MATLAB software will be used for the system design. There is no real time image capturing in this project. The set of vehicle images to be processed are stored and considered available in the database prior to image classification. Input of the system is a static vehicle frontal view image in query and the output of the system is the final vehicle classification type. The design is targeted to process vehicle images taken in the day time.

The system will analyze the vehicle frontal view and provide the classification based on the highest similarity value in comparison to the specifications set in the database for each class. The designed system will be an offline tool. MATLAB GUI will be developed, providing users the ability to upload an image in query and view the respective classification type.

1.5 Organization of the Project

This project write up is organized in five chapters. The first chapter introduces the project background. The motivation, project objectives, scope and the project organization are covered in this chapter.

Several previous works on the existing vehicle classification system and the recognition methods are reviewed to provide background to the project. Chapter two summarizes these literatures and provides some basic theory on various image processing techniques which are relevant to this project.

Chapter three focuses on the methods and design procedures applicable in developing the vehicle type classification system. These include the image processing steps and techniques which will be used in this design. The methodology and implementation plans which include preprocessing and 3 phases of image processing is described in this chapter.

Chapter four provides the results obtained from the designed Vehicle Type Classification System. This includes the results and discussion for each of the important design phases, and analysis on the performance accuracy.

Finally, the fifth chapter concludes the project and recommendations for future works are given here.

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