DESIGN OF VEHICLE DETECTION AND CLASSIFICATION THROUGH IMAGE PROCESSING TECHNIQUE FOR SURVEILLANCE SYSTEM

This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

PEONG YING CYING

B051720006

970125-04-5040

FACULTY OF MANUFACTURING ENGINEERING

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: **DESIGN OF VEHICLE DETECTION AND CLASSIFICATION THROUGH IMAGE PROCESSING TECHNIQUE FOR SURVEILLANCE SYSTEM**

Sesi Pengajian: **2020/2021 Semester 1**

Saya **PEONG YING CYING (970125-04-5040)**

mengaku membenarkan Laporan Projek Sarjana Muda (PSM) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. *Sila tandakan (√)

☐ SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysiasebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)

☐ TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/ badan di mana penyelidikan dijalankan)

☑ TIDAK TERHAD

Alamat Tetap:
107, Jalan 16,
Taman Sri Krubong,
75250 Melaka.

Tarikh: 8/2/2021

Disahkan oleh:

Cop Rasmi:
DR. RUZAIDI BIN ZAMRI
Senior Lecturer
Faculty of Manufacturing Engineering
Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

Tarikh: 08/02/2021

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “Design Of Vehicle Detection And Classification Through Image Processing Technique For Surveillance System” is the result of my own research except as cited in references.

Signature : ……

Author’s Name : Peong Ying Cying

Date : 8 February 2021

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

.....

(Dr Ruzaidi Bin Zamri)

ABSTRAK

Dengan kemudahan teknologi pada masa kini, sistem pengawasan telah ditingkatkan untuk melakukan pekerjaan mengumpulkan informasi untuk tujuan analisis, mengesan dan mengklasifikasikan objek untuk pengurusan lalu lintas dan bukan hanya untuk tujuan keselamatan. Walau bagaimanapun, kamera litar tertutup konvensional (CCTV) tidak disertakan dengan pemprosesan lebih lanjut pada video yang menyebabkan ketidakmampuan melakukan analisis statistik pada kenderaan. Selanjutnya, adalah tidak produktif untuk mengklasifikasikan kenderaan dengan menggunakan tenaga manusia secara manual. Tujuan projek ini adalah untuk mencipta algoritma untuk pengesanan dan pngelasan kenderaan melalui teknik pemprosesan gambar. Sistem yang dicipta merangkumi sistem perkakasan dan perisian yang berkompromi dengan kamera, komputer riba dan MATLAB. Teknik pemprosesan gambar yang akan digunakan adalah pembelajaran mendalam iaitu rangkaian saraf konvolusional (CNN) yang dibina dengan menggunakan MATLAB. Dua jenis model CNN yang telah dilatih diadopsi dalam projek ini adalah SqueezeNet dan GoogleNet. Jenis klasifikasi kenderaan adalah Sedan, SUV dan MPV. Sistem yang dibangunkan akan disahkan dari segi ketepatan, penarikan dan ketepatan. Hasil dari projek tersebut ialah sistem yang dibangunkan dapat melakukan pengesanan dan klasifikasi kenderaan dengan ketepatan keseluruhan 86.7% untuk SqueezeNet dan 97.5% untuk GoogleNet. Masa pengiraan setiap gambar adalah 0.092s untuk SqueezeNet dan 0.194s untuk GoogleNet.

ABSTRACT

With the ease of technology nowadays, the surveillance system has been upgraded to do such works of gather information for analysis purpose, detect for tracking and classification of object and traffic management despite only for safety purpose. However, the conventional closed-circuit television (CCTV) is not embedded with the further processing on the video were cause to the inability to conduct the vehicle statistics analysis. Furthermore, it is non-productive to classify the vehicle by manually using the manpower. This project aims to develop an algorithm for vehicle detection and classification through the image processing technique. The developed system includes the hardware and software system which compromise of a camera, laptop and MATLAB. The image processing technique that will be used is a deep learning convolutional neural network (CNN) which is constructing by using the MATLAB. Two types of pre-trained CNN models are adopted in this project are the SqueezeNet and GoogleNet. Types of classification of the vehicle are Sedan, SUV and MPV. The developed system will be validated in terms of the accuracy, recall and precision. The result of the project is the developed system can perform the detection and classification of a vehicle with an overall accuracy of 86.7% for SqueezeNet and 97.5% for GoogleNet. The computational time per image is 0.092s for SqueezeNet and 0.194s for GoogleNet.

DEDICATION

Only

My beloved father, Peong Ah Kim

My appreciated mother, Lim Chin Low

My adored brothers, Peong Chee Hao and Peong Wei hao

for giving me moral support, money, cooperation, encouragement and also understandings

Thank You So Much & Love You All Forever

ACKNOWLEDGEMENT

In the name of GOD, the most gracious, the most merciful, with the highest praise to GOD that I manage to complete this final year project successfully without difficulty.

My respected supervisor, Dr. Ruzaidi Bin Zamri for the great mentoring, kind supervision, advice and guidance that was given to me throughout the project. Besides I would like to thank to Engineer Assistant Encik Azwan and Encik Fairuz for lending the equipment in Makmal Simulasi 2 for this project. Furthermore, I would like to give a special thanks to my best friends who gave me much motivation and cooperation mentally in completing this report especially to, Leng Yee and Javin Khong for scientific advice while Hock Seng and Qi Hang for FYP report advice. They had given their critical suggestion and comments throughout my research. Thanks for the great friendship.

Finally, I would like to thank everybody who was important to this FYP report, as well as expressing my apology that I could not mention personally each one of you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AI	-	Artificial Intelligence
ANN	-	Artificial Neural Network
APA	-	American Psychological Association
BIT	-	Beijing Institute Of Technology
CCTV	-	Closed-Circuit Television
CLAHE	-	Contrast Limited Adaptive Histogram Equalization
CNN	-	Convolution Neural Network
COCO	-	Common Object In Contex
CPU	-	Central Processing Unit
CUDA	-	Computer Unified Device Architecture
3D	-	3 Dimensional
DL	-	Deep Learning
Fc	-	Fully Connected
FN	-	False Negative
FP	-	False Positive
FPS	-	Frame Per Second
GPU	-	Graphics Processing Unit
GTX	-	Giga Texel Shader Extreme
HDL	-	Hardware Description Language
HOG	-	Histogram Of Oriented Gradient
IEEE	-	Institute Of Electrical And Electronics Engineers

IP	-	Internet Protocol
JPG	-	Joint Photographic Group
LSVH	-	Large Scale Variance Highway
ILSVRC	-	ImagNet Large Scale Visual Recognition Challenge
ML	-	Machine Learning
MPV	-	Multi Purpose Vehicle
NAG	-	Nesterov Accelerated Gradient
PNG	-	Portable Networkgraphics
PX	-	Pixel
RAM	-	Random-access Memory
ReLU	-	Rectified Linear Unit
RGB	-	Red, Green, Blue
ROI	-	Region Of Interest
SD	-	Secure Digital
SGD	-	Stochastic Gradient Descent
SIFT	-	Scale-invariant Feature Transform
SMQT	-	Successive Means Of the Quantization Transform
SVM	-	Support Vector Machine
SUV	-	Sport Utility Vehicle
TN	-	True Negative
TP	-	True Positive
VOC	-	Visual Object Classes
YCrCB	-	Luminance, Chroma red, Chroma Blue
YOLO	-	You Only Look Once

LIST OF SYMBOLS

%	-	Percentage
s	-	Seconds

CHAPTER 1

INTRODUCTION

1.0 Background of Study

A surveillance system is a system that consists of a camera connected to a computer device or IP network for observing purpose in that area. Many of the surveillance systems are installed on the traffic light, home, parking lot, highway and corridor. In traditional, it was used for monitoring safety. With the ease of technology nowadays, the surveillance system has been upgraded to do such works of gather information for analysis purpose, detect for tracking and classification of object and traffic management despite only for safety purpose.

Vehicle detection and classification plays an important role in helping the surveillance system for further application of traffic monitoring, traffic management, vehicle tracking, vehicle statistics analysis, parking system monitoring and many more. The vehicle detection means to provide information by localization of the vehicle. The vehicle classification will later separate the recognise vehicle belongs to which category. The conventional method for vehicle detection and classification was done by using the instalment of sensor laid out under the road to collect data and analyse the needed information (Wang *et al.*, 2019). Later with the development of the computer vision technology, where the surveillance system was able to embed with the machine vision. The image processing techniques were then being implemented to detect and classify the vehicle. The image processing technique is to perform some operation on the image as

input and extract certain useful information needed as output from the image. There are two types of image processing which are the analogue image processing like hardcopies for printouts and photographs and digital image processing which manipulate the image by using the computer.

The traditional method for vehicle detection and classification in surveillance system through image processing are such as using the scale-invariant feature transform (SIFT) feature matching and extraction, gaussian mixture model, histogram of oriented gradient (HOG) and support vector machine (SVM). However, with the rapid upgrade of digital technology, the conventional methods are unable to meet the requirement for accurate precision for detection and classification. Therefore, the intelligence system with the deep learning algorithm has been introduced to process vehicle detection and classification. Deep learning is significantly proved from previous research that it shows a robust increase in performance for image recognition and classification field due to the recent advancement in the Graphics Processing Unit (Farag, 2018).

In this study, the Convolution Neural Network (CNN) which is a kind of deep learning from artificial intelligence will be implemented into the image processing for the detection and classification of the vehicle in the surveillance system.

1.1 Problem Statement

Surveillance system places an important role in controlling the management and safety of the traffic. In conjunction with the increase in the population of the human being in a country, a huge volume of vehicles has also been increased on road. In related to the safety management on road, the conventional closed-circuit television (CCTV) is not efficiently to track on the vehicle on the road since it is not embedded with the further processing on the video. So, when there is a crime happen in the traffic area. It is unable to filter, classify and track the vehicle efficiently. Furthermore, the detection and classification of the

vehicle are also very important in the automated car parking system. The current car parking system is not intelligent to guide the consumer to find free space for parking. This lead to problems of time-consuming when the consumer has to traverse through multi-storeyed and multi parking slots to find free space (Bonde *et al*., 2014). The situation is worsened when consumer keeps on find space but the parking slots already filled. The management in the car parking system is hard to achieve. It is also non-productive to classify the vehicle by manually using the manpower. Thus, by implementing the technology of deep learning in image processing of the video surveillance system will significantly help in improving all the problem statement listed above.

1.2 Objective

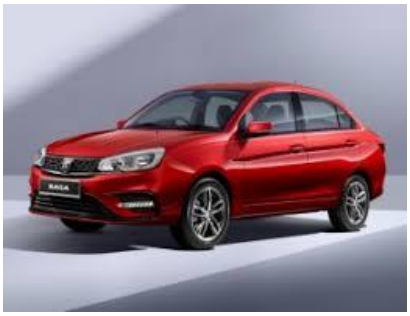
The objectives of this study are:

1. To develop an algorithm for vehicle detection and classification through an image processing technique.
2. To validate the developed system for vehicle detection and classification in terms of accuracy.

1.3 Scope

To archive the objective of the study, the scopes are as shown below:

1. The types of classification are Sedan, SUV and MPV.
2. The image processing of the detection and classification of a vehicle is using Convolutional Neural Network algorithm.
3. The software used to conduct the experiment is by using MATLAB.



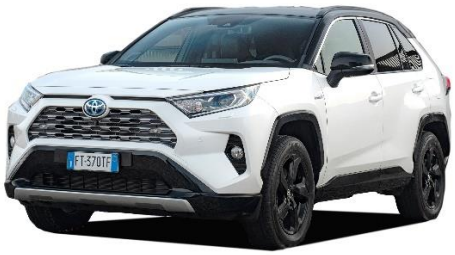


Figure 1. 1:Types of the vehicle to be classified: Sedan, SUV, MPV.