Faculty of Computer Science and Information Technology

VEHICLE COUNTING SYSTEM

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Bachelor of Computer Science with Honours (Software Engineering)

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This project is submitted in partial fulfilment of the requirements for the degree of Bachelor of Computer Science with Honours (Software Engineering)

Faculty of Computer Science and Information Technology

UNIVERSITI MALAYSIA SARAWAK

2023

SISTEM PENGIRAAN KENDERAAN

VONG KIAN SHENG

Projek ini merupakan salah satu keperluan untuk Ijazah Sarjana Muda Sains Komputer dengan Kepujian (Kejuruteraan Perisian)

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ABSTRACT

Vehicle counting is the process of detecting and logging the number of vehicles that enter a defined zone or cross a defined line. Vehicle counting is usually conducted either automatically, or manually by observers who visually count and record traffic on a hand-held electronic device or tally sheet. The vehicle counts can be used by local councils to identify which routes are used most, and to either improve the road condition or provide an alternative if there is an excessive amount of traffic. In Malaysia, the traffic surveillance is currently mostly done by human labour manually counting the number of vehicles passing through a route which is dangerous, time consuming, easily to produce error due to human careless mistakes and tiredness, and not cost effective. In addition, counting the vehicles manually by the roadside will affect the health of traffic surveyors as they are continuously exposed to the emission from vehicles. Therefore, this project proposed a video processing system that is using computer vision technology which is Vehicle Counting System that allows an automated and low-cost solution to count the vehicles passing through a route. It is expected that the proposed solution will perform better than current manual human labour with lower cost.

ABSTRAK

Pengiraan kenderaan ialah proses mengesan dan mencatat bilangan kenderaan yang memasuki zon tertentu atau melintasi garisan yang ditetapkan. Pengiraan kenderaan biasanya dijalankan sama ada secara automatik atau secara manual oleh pemerhati yang mengira dan merekod trafik secara visual pada peranti elektronik genggam atau helaian pengiraan. Kiraan kenderaan boleh digunakan oleh majlis tempatan untuk mengenal pasti laluan mana yang paling banyak digunakan, dan sama ada untuk memperbaiki keadaan jalan raya atau menyediakan alternatif jika terdapat jumlah lalu lintas yang berlebihan. Di Malaysia, pengawasan lalu lintas pada masa ini kebanyakannya dilakukan oleh tenaga manusia secara manual mengira bilangan kenderaan yang melalui laluan yang berbahaya, memakan masa, mudah menghasilkan ralat akibat kesilapan dan keletihan manusia, serta tidak menjimatkan kos. Di samping itu, mengira kenderaan secara manual di tepi jalan akan menjejaskan kesihatan juruukur trafik kerana mereka sentiasa terdedah kepada pelepasan daripada kenderaan. Oleh itu, projek ini mencadangkan sistem pemprosesan imej video yang menggunakan teknologi penglihatan komputer iaitu Sistem Kiraan Kenderaan yang membolehkan penyelesaian automatik dan kos rendah mengira kenderaan yang melalui sesuatu laluan. Penyelesaian yang dicadangkan itu dijangka akan berprestasi lebih baik daripada buruh manusia manual semasa dengan kos yang lebih rendah.

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CHAPTER 1: INTRODUCTION

1.1 Background

It is truly undeniable that one of the utmost importance for social and economic growth is road transportation. Road transportation plays an important role in global trade, where businesses depend on vehicles to deliver goods and therefore individuals are able to transact online orders. Thus, road transportation network is crucial to economic development in Malaysia as a developing country. Nowadays, the number of vehicles on the road is on the rise due to the increasing population and vast urbanisation. Lee (2017) reported that vehicle registration data released by the Malaysian Automotive Association (MAA) up to 30 June 2017 upshot a total of 28,181,203 units of vehicles on the road. In addition, according to the vehicle sales data released by the Malaysian Automotive Association in September 2022, a total of 67,659 vehicles were delivered to the buyers (Lim, 2022). The increasing number of vehicles indicates that the flow of the traffic must be well monitored to enable proper road planning and management in terms of new road construction, road detour, installation of traffic light, just to name a few. Traffic congestion occur when high number of vehicles travel simultaneously on routes within the same road network. This condition usually happens in urban cities such as Kuala Lumpur, Petaling Jaya and George Town during the rush hour. Traffic congestion can cause a lot of impacts to us such as consuming large amount of fuel, increasing the rate of car crashes, causing delays to the driver and polluting the environment.

Therefore, traffic surveillance needs to be conducted at various places from time to time to provide records for the professionals in transportation engineering careers to design improvements for roadways, traffic signs and signals, bikeways, and guardrails. However, it is inefficient for a company to deploy traffic surveyors to conduct the traffic surveillance as it is time consuming and laborious which will cause them to make mistakes such as counting the total number of vehicles passing through a route inaccurately due to their tiredness. Their traffic

surveillance can also be affected or delayed due to bad weather condition. In addition, the process of counting the vehicles manually by the roadside is also dangerous to the traffic surveyors or traffic enumerators.

Therefore, a solution regarding this issue needs to be provided. In this project, a vehicle counting system which is a video processing system that is using computer vision technology to detect and count the number of vehicles passing through a certain route automatically will be designed and developed. The traffic data generated by the system can be provided to third parties such as traffic police or transportation engineers so that improvements for transportation system can be designed, accidents thus can be reduced and highest level of efficiency in the transportation systems will be maintained.

1.2 Problem Statement

The expanding population and urbanization nowadays lead to high traffic especially at towns and main routes. Thus, traffic surveying is done in order to identify the underlying causes of some traffic-related issues as well as to gauge their severity, including the safety of pedestrians and traffic congestion. Traffic surveyors who deployed by a company for a particular traffic surveying project have to survey the traffic in the central business district by recording the traffic flow into and out of an area. In addition, they have to analyze the record by counting the number of vehicles passing through a route.

However, the problem arises where the time to collect and analyze the data is consuming since the traffic surveyors have to move from one place to another to conduct traffic surveying. Furthermore, counting the vehicles moving on the road manually is laborious and could produce inaccurate result because of errors and careless mistakes such as miscounting the vehicles made by human due to their tiredness. In addition, it is also dangerous for the traffic surveyors or traffic enumerators to count the vehicles by the roadside. Moreover, counting the

vehicles manually by the roadside will affect the health of traffic surveyors as they are continuously exposed to the emission from vehicles.

1.3 Scope

The scopes of the project are listed below:

- The system is designed and deployed as an automated census system to count the number of vehicles passing through a route.
- Traffic video will be pre-recorded or downloaded for the system to count the vehicles instead of setting up a camera and counting the vehicles in real time.

1.4 Objectives

- To design a vehicle counting system to count the number of vehicles passing through a route.
- To develop the vehicle counting system.
- To evaluate the vehicle counting accuracy.

1.5 Methodology

The methodology selected in this project is Rapid Application Development, which is focusing on developing a system or application rapidly through frequent iterations and continuous feedback in order to achieve better result for the product. RAD methodology has become an increasingly desired development method among companies around the world with the surge in demand for new software and new features in the modern technology age (Chien, 2020). Compared to traditional software engineering approaches, this methodology is always used in the rapid application development cycle and produces high-quality software. (Sasmito et al., 2020), which is suitable for this project due to the confined time period. There are 4 four phases included in RAD method and each of them are defined as below based on Figure 1.1.

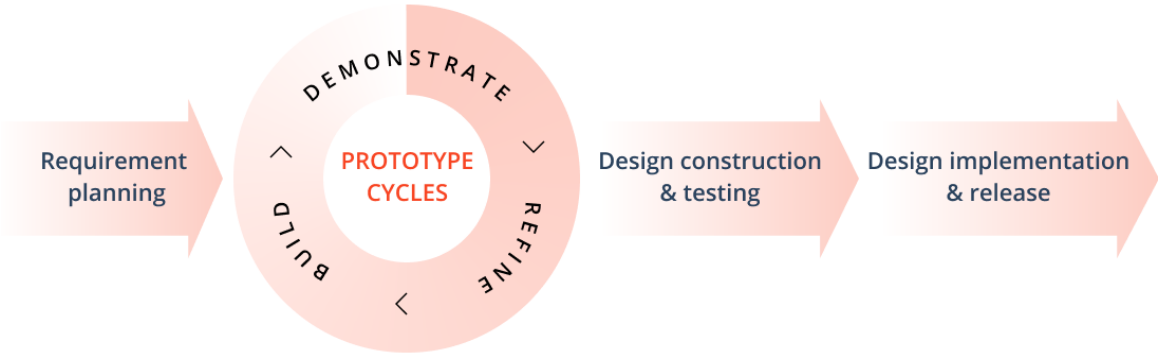

Figure 1.1: Rapid Application Development Model (Vaniukov, 2020)

1.5.1 Phase 1: Requirements Planning

This is the phase where the developer does an analysis to identify the issues and goals. Suitable source code editor, programming language and libraries to be used to develop the system are decided such as Visual Studio Code, Python, OpenCV and TensorFlow. Similar existing systems will also be reviewed if there is any to better understand and clarify the needs at this stage. Moreover, in this project, dataset of vehicles is also planned to be collected as many as possible for the system development and testing.

1.5.2 Phase 2: Prototype Cycles

In this phase, the prototype such as paper prototype about the Vehicle Counting System will be designed and then shown to the target users. The purpose for the demonstration is to receive feedback and improve the prototype simultaneously if there is any problem. Questionnaires are used to collect information about traffic, vehicle counting and prototype from the public. The process of building, demonstrating, and refining the prototype will be iterated until it meets the user's requirements.

1.5.3 Phase 3: Design Construction and Testing

This is the phase where the development process begins, a working system will be built based on requirements and prototypes. During this stage, tests are also run to look for bugs, errors, or failing components. Several traffic videos will be used by the system to test its accuracy of detecting and counting the number of vehicles passing through a route. The design of the interface and system's accuracy will also be improved simultaneously. In addition, user feedback is still required before the project is finalized.

1.5.4 Phase 4: Design Implementation and Release

This is the final phase when a working system is deployed on servers and ready to be implemented into a live environment after testing.

1.6 Significance of Project

The aim of this project is to develop and provide a computer vision-based system of detecting and counting the number of vehicles passing through a route for traffic surveillance control. This will be useful as people such as traffic surveyor doesn't have to record and count all the vehicles with them where the cars are passing by in real-time. The system can be very well-versed to attain the time-saving quality and be automated. As the system can be implemented anywhere as it only requires a camera or some wires for establishing the connectivity with the central system, therefore if the traffic is high at someplace, then from that area, an officer can monitor it and forward the information to next toll officer so that traffic congestion can be prevented.

1.7 Project Schedule

Project Name	Project Duration	Project Start Date	Project End Date
Vehicle Counting System	257	11/10/2022	24/6/2023

Task ID	Task Description	Task Duration	Start Date	End Date
1	Identify Project Title and Supervisor	7	11/10/2022	17/10/2022
2	Brief Project Proposal	11	18/10/2022	28/10/2022
3	Full Research Proposal	17	29/10/2022	14/11/2022
4	Chapter 1: Introduction	7	15/11/2022	21/11/2022
5	Chapter 2: Literature Review	18	22/11/2022	9/12/2022
6	Chapter 3: Methodology	21	10/12/2022	30/12/2022
7	FYP 1 Final Report	11	31/12/2022	10/1/2023
8	FYP 1 Presentation Slide	5	11/1/2023	15/1/2023
9	FYP 1 Symposium	3	16/1/2023	18/1/2023
10	Amendment and Modification for FYP 1	25	19/1/2023	12/2/2023
11	Compilation of FYP 1 Report	6	13/2/2023	18/2/2023
12	FYP 1 Finalization	3	19/2/2023	21/2/2023
13	RAD Model Phase 1: Requirements Planning	3	22/2/2023	24/2/2023
14	RAD Model Phase 2: Prototype Cycles	33	25/2/2023	29/3/2023
15	RAD Model Phase 3: Design Construction and Testing	10	30/3/2023	8/4/2023
16	RAD Model Phase 4: Design Implementation and Testing	10	9/4/2023	18/4/2023
17	Chapter 4: Implementation and Testing	27	19/4/2023	15/5/2023
18	Chapter 5: Conclusion and Future Works	14	16/5/2023	29/5/2023
19	FYP 2 Final Report	12	30/5/2023	10/6/2023
20	Submission of Final Year Project	14	11/6/2023	24/6/2023

Figure 1.2: Gantt Chart for Final Year Project 1

Figure 1.2 depicts the Gantt chart of the development of Vehicle Counting System.

1.8 Expected Outcome

At the end of this project, a computer vision-based system of detecting and counting the number of vehicles passing through a route will be produced. The system is expected to be able to detect, count and update the total number of vehicles passing through a route automatically and accurately. The analysed records produced by the system are expected to be useful for professionals in transportation engineering careers to design improvements for roadways, traffic signs and signals, bikeways, and guardrails.

1.9 Project Report Outline

1.9.1 Chapter 1: Introduction

This is the first chapter where the concept of this proposed system is discussed. The chapter begins with the background of the project and the current problems regarding the project background are identified. The objectives, scope, significance of the project and expected outcome are stated as well to describe the goals and general achievements in this project. In addition, the methodology chosen are briefly described along with project schedule throughout the whole project.

1.9.2 Chapter 2: Literature Review

This chapter focuses on comparing the existing system or function related to this project. The chapter also provides detailed information and a better understanding of the requirement of the project title.

1.9.3 Chapter 3: Requirement Analysis and Design

Chapter 3 discusses the methodology used during the project development, which is Rapid Application Development (RAD). This chapter describes the method used to collect related information, analysis of the collected data, logical design of the system such as database and logical diagram, and physical design which is the prototype of the system.

1.9.4 Chapter 4: Implementation and Testing

This chapter discusses the implementation and development of the system in this project based on the design in Chapter 3. The testing logs during the testing phase is included in this chapter as well.

1.9.5 Chapter 5: Conclusion and Future Work

Chapter 5 shows the conclusion of the whole project. This chapter is also discussing the suggestions or ideas to further improve the developed system.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter requires researching and studying on the information related to the project title, Vehicle Counting System using Deep Learning. The study provides detailed information and a better understanding of the requirement of the project title. The information obtained on related title includes reviewing of existing systems which provide an insight to assist the project development. In this chapter, three existing systems with similar features are selected to be reviewed and studied. Furthermore, a review of the technology used for the existing systems and proposed system is included. Reviews of comparison existing similar systems are also needed to determine the feasibility and necessity of developing the title.

2.2 Reviews on existing similar system

In this section, three existing systems which are Python OpenCV Traffic Counter, Video-based Real-time Adaptive Vehicle Counting System and Sydney Coordinated Adaptive Traffic System (SCATS) that are similar to Vehicle Counting System will be reviewed and compared.

2.2.1 Python OpenCV Traffic Counter

This system was developed by using Python and libraries such as OpenCV, NumPy, Matplotlib and Pandas and the author is Jorge Moreno. According to Moreno (2018), in this system, NumPy is used for creating matrices and vectors, OpenCV is used for reading and manipulating the image, and Pandas is used for keeping the data in an organized matter. A pre-recorded traffic video file will be opened through cv2.VideoCapture(). A data frame is created

by Pandas to keep the car tracking data organized where new columns are added as new cars are detected in the video.

In addition, this system uses a background subtractor which is cv2.createBackgroundSubtractorMOG2() to isolate the moving objects from a static background. Thresholds and transformations to the image of the video is applied by the system for better isolation of moving objects. Moreover, this system converts the image of the video to grayscale for better analysis and applies the background subtractor to distinguish moving objects. The cars shown in the traffic video will be isolated by the system into shapes that can be easily detected through the defined type and size of the kernel which adjusts the image according to the morphological transformations apart from removing the grey portions. The transformation filters out noise and isolates cars in the traffic video which then constructs the cars into solid shapes that are easy to be detected and tracked. A horizontal line is created as an indicator of a car passing through a route.

The system detects and tracks the cars shown in the traffic video by drawing contours around the isolated cars, then creating an outline with the outermost points of the contours for each car. In this system, the minimum and maximum areas for a contour to be counted passing through the horizontal line are defined. Contours that do not meet certain criteria will be filtered out by the system. One of the criteria is that the contour must be the parent contour, in other words, it cannot be within another contour, because a car cannot be within another car. This is important because sometimes small contours are within other contours due to the transformations applied earlier not eliminating every imperfection. In addition, any contour that are too small such as noise or too large that is not a vehicle will be removed. The system also saves the data frame to a CSV file which contains all the carids and centroid values for each frame to be used later on for plotting the movement of the cars.