



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DEVELOPMENT OF OBJECT RECOGNITION  
SYSTEM BY USING RASPBERRY PI**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Computer Engineering Technology (Computer Systems) with Honours.

By

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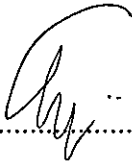
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## APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours. The member of the supervisory is as follow:

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## ABSTRAK

*Projek ini bertujuan untuk merekabentuk dan membangunkan sistem pengesanan objek yang boleh digunakan untuk pelbagai tujuan seperti pengesanan wajah, pengesanan ciri dan pengesanan nombor kenderaan. Dengan mengkaji kaedah yang digunakan dalam sistem pengesanan objek terdahulu, sistem pengesanan objek yang dicadangkan dalam projek ini bertujuan untuk mengurangkan kos, penggunaan kuasa yang lebih rendah dan mudah alih. Komputer papan tunggal iaitu Raspberry Pi 3 model B + dipilih sebagai pemproses utama dan kamera Raspberry Pi 8MP V2 sebagai peranti paparan untuk sistem ini. Kamera Pi akan menangkap imej atau video dari objek dalam masa nyata. Kemudian imej atau video yang ditangkap dikesan, diklasifikasikan dan dicam dengan menggunakan kaedah Single Shot Detector (SSD). Selepas objek dikesan, objek dibatasi oleh kotak penghad dengan nama kelas objek dan kebarangkalian. Rangkaian SSD menjana skor untuk objek, setulesnya skor tertinggi dipilih sebagai kelas bagi objek yang dibatasi. Ketepatan sistem diuji dalam dua keadaan yang berbeza iaitu di atas latar belakang kosong dan latar belakang kontras yang baik. Keputusan menunjukkan bahawa ketepatan sistem dalam latar belakang kosong adalah 90% manakala ketepatan sistem dalam latar belakang yang rumit adalah 55%. Ketepatan sistem dengan kontras yang baik adalah 80%, iaitu 45% lebih tinggi daripada ketepatan sistem dalam kontras yang tidak baik.*

## ABSTRACT

This project aims to design and develop an object recognition system that can be used for various purposes such as face recognition, feature recognition and vehicle number recognition. By studying the method used in previous object recognition system, the object recognition system proposed in this project aims to reduce costs, lower power consumption and portable. Single board computer namely Raspberry Pi 3 model B+ is selected as the main processor and Raspberry Pi 8MP camera V2 as the viewing device for this system. Pi camera will capture image or video of an object in the real-time. Then the captured image or video is detected, classified and recognized by using Single Shot Detector (SSD) approach. After the object is detected, the object is bounded by bounding box with the class name of object and the probability. The network of SSD generates scores for object, then the highest score is picked as the class for the bounded object. The accuracy of the system is tested in two different conditions which are good contrast of the environment and plain background. The results show that the accuracy of system in plain background is 90% while the accuracy of system in complex background is 55%. The accuracy of the system in good contrast is 80% which is 45% higher than the accuracy of system in poor contrast.

## **DEDICATION**

This thesis is dedicated to my parents and family members who always gives me support and taught me that even the largest task can be accomplished if it is done one step at a time.



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## LIST OF ABBREVIATIONS

<b>ALPRS</b>	-	Automatic license plate recognition system
<b>BBM</b>	-	Bounding Box Method
<b>COCO</b>	-	Common Objects in Context
<b>DBB</b>	-	Default Bonding Box
<b>FPS</b>	-	Frame Per Second
<b>FRS</b>	-	Face Recognition System
<b>GTBB</b>	-	Ground-truth Bounding Box
<b>IoU</b>	-	Intersection Over Union
<b>LPDR</b>	-	License Number Plate Detection and Recognition
<b>LPR</b>	-	License Plate Recognition
<b>mAP</b>	-	Mean Average Precision
<b>OM</b>	-	Otsu's Method
<b>OpenCV</b>	-	Open Source Computer Vision Library
<b>PBB</b>	-	Predicted Bounding Box
<b>PC</b>	-	Personal Computer
<b>RGB</b>	-	Red, Green, Blue
<b>RPi</b>	-	Raspberry Pi
<b>SSD</b>	-	Single Shot Detection
<b>SVM</b>	-	Support Vector Machines
<b>TMM</b>	-	Template Matching Method
<b>YOLO</b>	-	You Only Live Once

# CHAPTER 1

## INTRODUCTION

Object recognition is a computer technology linked with image processing and computer vision that recognize a given object in real-time image and video. This is not an innovative technique but enhancement in object recognition is still needed. This also is a challenging task for computer vision systems. Object recognition algorithms need to be trained using many images to get an efficiency and accuracy recognition system. The research for the object recognition system is more concerned with the ability to recognize generic classes of the object rather than just specific instances. Object recognition system brings benefits for humans. For example, humans can recognize the object in the real life effortlessly. Numerous applications of object recognition that have been well analysed including face recognition, character recognition, and vehicle number plate recognition. Object recognition can be used for many purposes such as surveillance.

### 1.1 Background

The elementary concept of object recognition system is for detecting, classifying and recognition of objects. Object recognition is a computer technology that linked with image processing and computer vision that focuses on detecting, classifying and recognition item of a certain class such as humans, bottles, chairs, and cars in real-time image and videos. Furthermore, the object recognition system is a significant system in image processing and computer vision. It is related with determining the identity of an object being observed in real time image from a set of known tags. Object recognition

can be used for several purpose including surveillance. The object recognition algorithms need to be trained by using digital images. Several images must be gathered in order and used to classify new objects.

The aim of this project is to develop an object recognition system that able to reduce human efforts by implementing image processing technique in Raspberry Pi (RPi). RPi is the microcontroller of the recognition system. RPi acts as the brain of the recognition system where all processes are handled by it. Many research and development have been carried out on the personal computer in order to obtain high accuracy of real-time object recognition. In this project, a single board personal computer which is RPi is used as the microcontroller of this system. RPi is also a low power consumption and portable. The portability of RPi allows this proposed system to be set up in any place. The pi camera also the main component of the recognition system as it is used to capture the real-time image and video.

The developed system will undergo a series of real-time testing to evaluate its performance based on the accuracy and efficiency of recognition. The developed system is expected to identify objects such as humans, bottles, chairs, and cars efficiency and accurately.

## **1.2 Statement of the Purpose**

An object recognition system is developed that able to diminish human effort in daily applications. There are two objectives to achieve the goal which are:

1. To develop an object recognition system based on Single Shot Detection (SSD) approach.
2. To test the accuracy of the developed recognition system in real time.

### **1.3 Problem Statement**

Object recognition in real time has turned out to be one of the extremely important applications for industries to ease user, save time and to realize parallelism. Numerous works and researches have been carried out on the system development based on various methods. However, the system still requires further improvement to achieve higher accuracy and efficiency. Furthermore, the issues that involve recognizing people and objects is still a challenging application in image processing due to significant variations exhibited by real-time image. The systems that can efficiently and accurately recognize the object are still under rapid development.

### **1.4 Project Scope**

This project mainly focuses on the ability to recognize an object by implementing image processing techniques in a single board personal computer which is RPi 3 model B+ while Python is used to program the RPi 3 B+. Object recognition system is concerned with determining the identity of a given object in an image or video sequence from a set of the recognised tag.

### **1.5 Project Significant**

This project is aimed to provide an accurate object recognition system which plays a major role in regular lifetime. This recognition system provides a low equipment cost, low maintenance expenses, simple infrastructure, and high-quality computer vision system. This project brings a lot of benefit to users because it can be used for various purpose including surveillance. Therefore, the development of an object recognition

system is significant applications for industries to ease user, save time and to realize parallelism.

## **1.6 Structure of Project**

Chapter 1 will be briefly described about the possibility of the project. In this field, a simple introduction of recognition system is provided. The objective, problem statement and the scope of this project also included in this part. The features of this project are described in Chapter 2. Apart from this, the ideas, methods and software that can be used to develop the recognition system also discussed in this part. In Chapter 3, the methodology of this project is explained in this part. The flow of this project will be illustrated in methodology to achieve the objective effectively. In addition, the hardware that will be used to develop the recognition system is described in section of hardware development while the software and method that will be applied in the recognition system is discussed in part of software development. The analysis result and discussion for this project is provided in Chapter 4. The analysis result and discussion are acquired based on the methodology that have been discussed in Chapter 3. In Chapter 5, the conclusion and recommendation are discussed for the future improvement.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

Nowadays, there are numerous applications of object recognition that have been well studied. For example, vehicle number plate recognition system (Bhat and Mehandia, 2014; Babu and Raghunadh, 2017; Dewan *et al.*, 2015; Prabhakar, 2014), face recognition ((Owayjan *et al.*, 2016)), formatted text recognition (Shetty and Heraje, 2017), object recognition (Ahmad *et al.*, 2014; Kumar Anumula *et al.*, 2015; Soo, 2015; Gupta *et al.*, 2017; Kalshetti, 2014) and so on. There are sundry works on object detection via sliding windows, deformable part models, viola and jones, etc. However, the accuracy of the system still needs to improve. Object recognition is an eminent computer technology connected with image processing and computer vision that focus on detecting objects, then classify and recognize the object in a class (such as furniture, animals, humans) in digital images and videos.

Atkinson *et al.* (2000) described the term of object recognition as deciding the meaning of an object. To recognize an object, it is primarily shaped, alongside size, color, texture, and orientation which we use to do so. Biederman (1987,1990) proposed a theory of object recognition which extend existing theory by Marr and Nishidara (1978). Finally, scientist found a few new ways to recognize the object, animals or face.

This chapter gives an overview of current knowledge on object recognition system including the major finding in both theoretical and methodological way. In addition, some related works are also reviewed.