



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF OBJECT FOLLOWING ROBOT

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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ABSTRAK

Robot pengikut objek adalah robot yang boleh mengikuti objek sasaran tanpa henti apabila ia telah berjaya mengesan objek tersebut. Apabila objek bergerak, ia mengikuti objek dan apabila objek berhenti, ia turut berhenti. Dalam kebanyakan pelaksanaan masa kini, kamera keselamatan yang digunakan dalam pemantauan lalu lintas, pengendalian proses perindustrian, dan pengesanan jenayah dipasang pada kedudukan tetap. Dengan cara ini, sistem ini hanya dapat menangkap imej objek dalam gerakan 360° yang mana menghadkan kawasan pemantauan. Tujuan projek ini adalah untuk membangun robot pengikut objek yang menjejaki objek sasaran dan mengikutnya menggunakan kaedah berasaskan warna dan kontur. Projek ini menggunakan bola sebagai objek sasaran. Robot pengikut ini terdiri daripada tiga komponen utama iaitu mikropengawal, kamera dan motor DC. Raspberry Pi digunakan untuk pemprosesan imej dan juga bertindak sebagai mikropengawal untuk mengawal pergerakan robot. Kamera dipasang pada Raspberry Pi untuk menangkap imej objek tersebut. Selain itu, dua motor DC digunakan untuk membolehkan pergerakan robot dan paparan monitor iaitu, telefon pintar digunakan untuk memaparkan objek yang ditangkap oleh kamera. Hasil daripada projek ini dianalisis untuk mengenal pasti prestasi robot pengikut objek. Keputusan menunjukkan bahawa ketepatan pengesanan warna dengan menggunakan kaedah berasaskan warna adalah 87.3% dan ketepatan robot bergerak maju ke sasaran objek adalah 90% manakala ketepatan robot bertukar kiri, dan kanan adalah 86%.

ABSTRACT

An object following robot is a robot that can follow a target object relentlessly when it has succeeded detecting the object. When the object moves, it follows the object and when the object stop, it stops. In most of the current implementations, the security cameras used in monitoring traffic, industrial process controlling, and crime detection are mounted at a fixed position. This way allows them to capture only the images of objects within their 360° movement which limits the monitoring area. Thus, the purpose of this project is to develop an object following robot that tracks a target object and follows it using colour-based and contour-based methods. To be specific, this project considers a ball as the target object. This following robot consists of three main components which are microcontroller, camera and DC motors. The project uses Raspberry Pi for image processing and it also acts as microcontroller to control the movement of the robot. A camera is attached to the raspberry pi to capture the object. Besides, two DC motor are used to allow the movement of the robot. In addition, a monitor display which is a smartphone is used for displays the object that is captured by the camera. The result of this project is analysed to identify the performance of the object following robot. The results show that the accuracy of the colour tracking by using colour-based method is 87.3% and the accuracy of the robot goes forward to target object is 90% while the accuracy of the robot turns left, and right are 86%.

DEDICATION

This thesis is dedicated to my beloved parents who always give their endless support and encouragement when I thought of giving up throughout the process. I always appreciate all they have done.

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LIST OF SYMBOLS

- x** - Coordinate of circle (x-axis)
- y** - Coordinate of circle (y-axis)
- r** - Radius

LIST OF ABBREVIATIONS

AI	Artificial Intelligence
DC	Direct motor
HSV	Hue Saturation Value
IR	Infrared Sensor
KLT	Kanade Lucas Tomasi
MATLAB	Matrix Laboratory
NumPy	Numerical Python
OpenCV	Open Source Computer Vision Library
OS	Operating System
PC	Personal Computer
RGB	Red Green Blue
VDM	Vision Development Module

CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, robots are expected to coexist and help human in different environment. In 1954, the first digitally and programmable robot called Unimate is operated by George Devol (Zamalloa *et al.*, 2017). According to Oxford Dictionary, robotics is a branch of technology that involves the design, construction, operation and application of the robot. The robots are programmable machine follows the instructions which usually able to carry out the action autonomously. In the second half of 20th century, the fully autonomous robot only appeared.

Object tracking is defined as a fundamental basis of Artificial Intelligence (AI) and robotic system. It necessary for the surveillance application, smart tracking of moving object, guidance of autonomous vehicles and so on. Tracking is a process used for observing the specific or multiple moving persons and objects in a camera with respect to time. The applications of security cameras are in monitoring traffic regulation, industrial process controlling, and crime detection are generally defined as a problem of estimating the position of an object over a sequence of images. This is because they are only at a fixed position and 360° movement to camera which cause the limitation area of monitoring. To overcome this problem, a following robot with a monitor display could be used for surveillance. Surveillance is a process that monitoring the behaviours or activities on people, animals or objects from a distance through camera. This robot can

cover a wide area and can reposition itself in response to the movement of the target object.

Raspberry Pi with a camera is used for object tracking based on the colour and then the robot will follow the object. In this project, the object used for tracking is a ball. Only a single object is detected at one time. This object is then display on the monitor. This paper describes toward the simple design and effective algorithm for object tracking. This robot is more cost effective and straightforward compare to others robot.

Throughout this project, there are some problems which are the implementation issues related to limitations of software technologies and the performance issues related to code. All attempts at overcoming these problems are discussed in this report.

1.2 Problem Statement

There are a lot of techniques are used to track and detect the object. All of them have their advantages and disadvantages. A suitable technique needs to be used for the purpose of the project. Furthermore, the problem of estimating the position of an object become an issue in the monitoring traffic regulation, industrial process controlling and crime detection. This is because they only at the fixed position and 360° movement to camera. The target object easily to lose track due to the limitation area of monitoring.

1.3 Objective

The aim of this project is to develop the object following robot to allow a wider monitoring area. There are two objectives are listed as below:

1. To develop an object following robot using colour-based method and contour-based method on Raspberry Pi.
2. To test the performance of the object following robot in real time.

1.4 Project Scope

This project focuses on the ability to track an object by using some image processing techniques and then follow it. Only one object can be track at one time since a single object tracking method is used in this project. A specific colour which is red colour detected. Raspberry Pi 3B+ model with a python programming language is used.

1.5 Project Significant

This project is made to track an object, then the robot follows the target objects and display it to the screen for surveillance purpose. The project gives the advantages for the user in order to track the position of the targeted object and followed it. Therefore, the area of monitoring will become wide.

1.6 Structure of Project

This report consists of 4 chapters which discuss the requirement of the project details. Chapter 1 describes the introduction of the project which includes the background, objective, problem statement, scope of the project and project significant. Chapter 2 discusses the literature review which contain the background study and related work of

this project. It contains the methods, technologies used by the researchers. Chapter 3 discusses the methodology. The methodology contains the project process flow in order to achieve the objective of the project. It also describes the system design which contains the development of hardware and software. In Chapter 4, the result and discussion are obtained based on the methodology mention in Chapter 3. In Chapter 5, conclusion and recommendation are discussed for future improvement.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Object following or tracking is an important field in computer and machine vision application. Following or tracking is a process used for observing the specific or multiple moving persons and objects in a camera with respect to time. This technique is applied in numerous applications like in monitoring traffic regulation, industrial process controlling, and crime detection.

This chapter discusses the background study of object tracking system and following robot. Numerous software used to track the object are compared. There are many different algorithms for tracking process which are Kalman filter, Mean shift, Kanade Lucas Tomasi (KLT), Viola Jones, Adaboost and Camshift algorithm. Other ways to classify methods in object tracking are color-based, motion-based, shape-based and texture-based method.