REAL-TIME OBJECT TRACKING SYSTEM FOR 2-DEGREE OF FREEDOM

(DOF) ROBOTIC ARM

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FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : **Real-Time Object Tracking System For 2-Degree Of Freedom (DOF) Robotic Arm**

Sesi Pengajian : | 1 | 3 | / | 1 | 4 |

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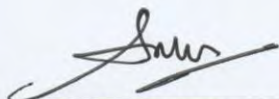
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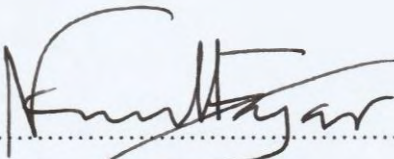
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To my ever dearest mom and dad.

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ABSTRACT

This project is about a Real-Time Object Tracking with 2 Degree Of Freedom (DOF) robotic arm. Object tracking is a technology related to machine vision or image processing by detecting an instances of specific objects. The main goal of this project is to design and develop an accurate target tracking system using a camera. The robot will continuously track a target with a camera mounted on its 2-Degree Of Freedom (DOF) robotic arm. The images frame acquired or captured by webcam will be processed using by MATLAB algorithm, where the selected moving object will be detected and tracked. The centroid of the object will be located and MATLAB will compute and transform the centroid position (pixels) into pan-tilt servos. This information will be fed to the Arduino, which is used to manipulate the pan-tilt servos to continuously track the moving object using PID controller. PID controller will enhance the pan-tilt servos responsiveness and movement aggression to track an object in real-time with minor delay. This project has a capability of sustainable to improve the system control and functions until it can be produce as a product of robotic in market to help people and also as a facility to society.

ABSTRAK

Projek ini adalah mengenai Penjejakan Objek Masa Sebenar dengan Penjejakan 2 Darjah Kebebasan (DOF) lengan robot. Objek pengesanan adalah teknologi yang berkaitan dengan penglihatan mesin atau pemprosesan imej untuk mengesan sesuatu objek yang tertentu. Matlamat utama projek ini adalah untuk merekabentuk dan membangunkan sistem pengesanan yang tepat dengan menggunakan kamera. . Robot ini akan terus menjejaki sasaran dengan kamera yang dipasang pada 2-darjah kebebasan (DOF) lengan robot itu. Rangka Imej yang diperolehi atau ditangkap oleh kamera web akan diproses menggunakan algoritma oleh MATLAB, di mana objek bergerak yang dipilih akan dikesan dan dijejaki. Sentroid objek akan ditempatkan dan MATLAB akan mengira dan mengubah kedudukan sentroid (piksel) ke dalam dongakan-tolehan servo. Maklumat ini akan hantar kepada Arduino, yang digunakan untuk memanipulasi dongakan-tolehan servo untuk terus menjejaki objek yang bergerak menggunakan pengawal PID. Pengawal PID akan meningkatkan responsif dan pergerakan yang agresif untuk dongakan-tolehan servo dalam mengesan objek dalam masa sebenar dengan kelewatan yang kecil. Projek ini mempunyai keupayaan yang mampan untuk meningkatkan kawalan sistem sehingga ia boleh dihasilkan menjadi produk robotik di pasaran untuk membantu orang ramai dan juga sebagai kemudahan kepada masyarakat.

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LIST OF SYMBOLS / ABBREVIATIONS

DC   -   Direct Current

DOF   -   Degree Of Freedom

LED   -   Light-Emitting Diode

PC   -   Personal Computer

PID   -   Proportional, Integral, Derivative

PWM -   Pulse Width Modulation

OS   -   Operating System

USB   -   Universal Serial Bus

GUI   -   Graphic User Interface

φ -   phi

Δ -   Increment

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1   Background

This chapter will state briefly all the problems statement, objectives and the scope of this project. The purpose of this project is to develop real-time object tracking system for 2-Degree Of Freedom (DOF) robotic arm, which is a robotic based application with an image processing technique integrated. Object tracking is a technology related to machine vision or image processing by locating and an instances of specific object over time in the series of images produced by a camera. Objects can be identified from an image to the subsequent images based on their unique features (e.g. template matching based algorithm by taking the group of pixel values and respective image coordinate or histogram based matching). In order to be able to instruct the robot to track the object in real-time with respect to the moving

object inside the high frame rate and high resolution images, powerful computing unit will be required to complete the process of the tracking algorithm.

1.2 Problem Statement

Robotic is the technology involved with the combination in design, operation, and applications. Object tracking robot is not widely implemented in terms of application itself since people rely on manual tracking robots due to less complexity and low cost. There are several problems that led to propose the new system are as follows:

a) Object tracking requires high computing power which is hardly handle by embedded system.
    i. Common embedded system required high computing processor to operates, without the proper processing system, the tracking object might not be accurate.

b) The performance of target (object) tracking using the robotic arm is not being determined.
    i. Target tracking system in image processing has a lot of approaches and yet most of the system is not being determine to be optimized in term of performance.
    ii. Time to time there will be a new systems and algorithm approach to increase the performance in target tracking.

c) Manual robotic arm controlled by human is not giving the best accuracies at targeting.
    i. Manual robot is obviously depends on the one who control it.
    ii. To be the best at targeting using manual robot required training and time consume.

1.3   Project Objectives

The main objective of this project is to build an application of robotic arm that have a good response and most accurate target tracking using MATLAB and Arduino Uno. Beside by implement such development process, it would enhance to other new based product that using object tracking based system. Among others objectives are stated as follows:

1. To develop a 2-DOF robotic arm by using Arduino Uno with pan and tilt capability.
2. To integrate between the software (MATLAB) and hardware (Arduino Uno and servo motors).
3. To implement and evaluate the performance of the target tracking using PID concept.

1.4   Project Scopes

Scope of work for this project is regarding to all objectives that are mentioned. Before the project is conduct, work planning and time management operation must took a placed systematically where everything needs to be done according to the right procedures schedule in order to produce a quality project. Some theories of software and hardware basic are need to be known in order to get better understanding of software (MATLAB) and hardware (Arduino Uno and servo) behavior. The first part is to identify a preferable method to find a communication solution between Arduino Uno and MATLAB algorithm process with external devices. MATLAB algorithm has a lot of approaches to be implement since MATLAB provided various toolboxes and commands to assist user to create a system. Thus, the best algorithm should be less memory used, good structured, simple and less processing command so that the system will become stable. Webcam with integrated driver (plug and play) is preferable to avoid crash or malfunction (most of previous webcam are required drivers and have possibility drag to compatibility issue with Windows OS), it will be connect to PC by USB cable.

Image Acquisition tool in MATLAB toolbox is a perfect tool to obtain video recording frame by frame. Meanwhile, Arduino Uno has provide a virtual serial port thus, Arduino can be connect to PC via USB cable. Laser will be place on top of pan-tilt servos and will be point at the center of pixel's frame, all does by calculation to get better algorithm.

1.5   Project Overview

The first chapter focuses on the introduction, which is background, problem statement, objectives, scope and the important of project. For background and problem statement explains about introduction of this project and the necessary to implement this project. The main factor of choosing the project title and purpose of project was described under the objectives. The brief operations of this project is explained under the project scope.

The second chapter, describes about the literature review in which held on research before the start of the project based on review by reading such theses, journals, books, newspapers, internet, lecturer notes and so on to get more clear information about the types of object tracking, the method and technique to do an object tracking and identify the improvements methods used in handling this problem. It is a more detailed description about keywords of the project and also to guide on making the project. In this chapter, the information is obtained merely through to reading only. For information and achieve the objectives described in the study, the researchers will determine the appropriated methodology to carried out of this project.

The third chapter encompasses of the methodology of the project. This chapter is about a process or steps are used for a development of project or research of the project. In developing this project, some of the methodology or approach has been identified as a guideline for the flow of the project. The detail from the research methods is in producing a real-time object tracking system for 2-Degree Of Freedom (DOF) robotic arm. In creating a good real-time object tracking system, the analysis

is done to find a solution in this problem. Each analysis and function in algorithm and control system is explained in more detail.

The fourth chapter describes about the result and analysis. This chapter will be discussed about the result from the data analysis and the testing of the project outcome. The overall technique used in image processing by MATLAB such as red colour channeling RGB image to grayscale, image subtraction, image filtering, converting from grayscale to binary, area open selection, regionprops and some other properties will be discussed the observation made during the development of this project.

Finally, for the last chapter of the report covers the conclusion and recommendation for improvement. This chapter describes the conclusion for development of this project and the recommendation of project for the future. This section is a whole summary of the project development.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is emphasize on literature review and research in related scope in development of project Real-Time Object Tracking System for 2-Degree Of Freedom (DOF) Robotic Arm. The research is to improve the system with good step response and time taken reduction while tracking an object in high speed movement and discuss about the projects backgrounds. The research was carried out using a number of reference materials such as books and journals and also including the website to assist this study but most of the research from journal will be reviewed and discussed. The research conducted to obtain scientific information, analyses and reviews of the concept and weaknesses of existing methods to be improved through to develop this project. All the parameters are related to this project will be describe by methods and parameters used in previous research.

2.2   Object Representation

According to Alper Yilmaz, Omar Javed, and Mubarak Shah from an article of "Object tracking: A survey", states that in a tracking scenario, an object can be defined as anything that is of interest for further analysis. For instance, boats on the sea, fish inside an aquarium, vehicles on a road, planes in the air, people walking on a road, or bubbles in the water are a set of objects that may be important to track in a specific domain. Objects can be represented by their shapes and appearances. The types of object representation was shown on Figure 2.1 [1].
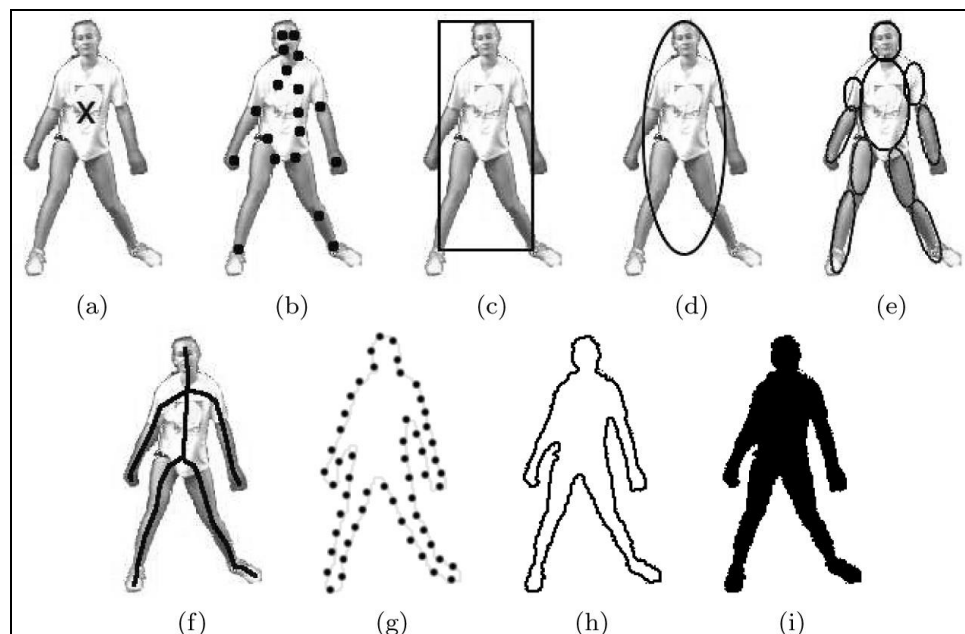

Figure 2.1. Types of Object Representation: (a) Centroid, (b) multiple points, (c) rectangular patch, (d) elliptical patch, (e) part-based multiple patches, (f) object skeleton, (g) complete object contour, (h) control points on object contour, (i) object silhouette [1].

The object is represented by a point, that is, the centroid in Figure 2.1(a) or by a set of points in Figure 2.1 (b). In general, the point representation is suitable for tracking objects that occupy small regions in an image. When an object shape is