



Faculty of Engineering

**IMAGE PROCESSING FOR ROBOT VISION APPLICATION
USING MATLAB**

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**Bachelor of Engineering with Honours
(Mechanical and Manufacturing Engineering)**

2010

UNIVERSITI MALAYSIA SARAWAK

R13a

BORANG PENGESAHAN STATUS THESIS

Judul: **IMAGE PROCESSING FOR ROBOT VISION APPLICATION USING MATLAB**

SESI PENGAJIAN: 2009/2010

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**IMAGE PROCESSING FOR ROBOT VISION APPLICATION USING
MATLAB**

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Thesis is submitted to
Faculty of Engineering, University Malaysia Sarawak
In Partial Fulfillment of the Requirements
For the Degree of Bachelor of Engineering
With Honours (Mechanical and Manufacturing Engineering) 2010

To my beloved family and friends

ACKNOWLEDGEMENT

I would like to take this opportunity to express my thanks and appreciations to people who support and encourage me in accomplish this project.

First of all, I would like to thank my project supervisor Mr. Shahrol Bin Mohamaddan for his patient, supervision, guidance and continuous support throughout the project. My dear beloved parents, without your support, encouragement and care my whole project would be incomplete. Besides that I would like to thank my friends who have also supported me and also helped me throughout the project. Thank you to all the parties involved.

ABSTRACT

Robot vision is one of important sensor used in field of robotics. There are still wide ranges of area to improve the robot vision. The objective of this project is to develop a Graphical User Interface (GUI) application which is user friendly to human and the robot can interpret the segmented object with object recognition. This project will focus on segmentation using edge detection, thresholding and color segmentation. The segmented object will be use in object recognition. The source code is written in MATLAB. The segmentation using edge detection 'Sobel Edge Detector' and color segmentation using L*a*b* color space are found to be useful in develop the GUI application. Algorithms to segment the required object and to find the object location (distance and centroid coordinates) are found in experiment and proposed into the GUI application. The GUI application is able to work in real-time image effectively in edge detection. Calculation error in the application can be reduced with a good illumination.

ABSTRAK

Penglihatan robot merupakan salah satu penderia penting dalam bidang robotik. Masih banyak ruang yang dapat meningkatkan penglihatan robot. Objektif projek ini adalah mencipta satu aplikasi *Graphical User Interface (GUI)* yang mesra pengguna dan robot dapat mentafsir pemecahan objek dengan objek pengesahan. Projek ini fokus dalam pemecahan menggunakan *edge detection*, *thresholding* dan *color segmentation*. Pemecahan objek akan digunakan dalam objek pengesahan. Kod punca telah ditulis dengan menggunakan *MATLAB*. Pemecahan menggunakan *edge detection* 'Sobel Edge Detector' dan *color segmentation* menggunakan *L*a*b* color space* dijumpai berguna dalam mencipta aplikasi *GUI*. Algoritma untuk memecahkan objek yang diperlukan dan mencari lokasi objek (jarak dan koordinat *centroid*) diperolehi dalam eksperimen dan dicadangkan ke dalam aplikasi *GUI*. Aplikasi *GUI* dapat berjalan dalam *real-time image* dengan berkesan dalam *edge detection*. Pengiraan ralat dalam aplikasi boleh dikurangkan dengan menggunakan *illumination* yang baik.

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LIST OF ABBREVIATION

x	-	Coordinate x
y	-	Coordinate y
$f(x)$	-	One-dimensional function
$f(x, y)$	-	Function of two variables
d	-	Distance
h	-	Height
w	-	Width
A	-	Area
NaN	-	Undefined numerical result
Pixel	-	Elements of a digital image
z	-	Zoom ratio

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Digital image processing refers as processing digital image by means of a digital computer (Gonzalez & Woods, 2008). Image processing is a set of computational techniques for analyzing, enhancing, compressing, and reconstructing images. The main components are importing, in which an image is captured through scanning or digital photography; analysis and manipulation of the image, accomplished using various specialized software applications; and output. Image processing has extensive applications in many areas, including astronomy, medicine, industrial robotics, and remote sensing by satellites (image processing, 2009). Image processing for robot vision will improve products quality, save time and reduce labor cost.

Computer vision is a field of robotics in which the programs attempt to identify objects represented in digitized images provided by video cameras that enable robots to “see.” A lot work has been done on stereo vision as a support to object identification and location within a three-dimensional field of view. Recognition of objects in real time, as would be needed for active robots in complex environments, usually requires computing power beyond the capabilities of present-

day technology (computer vision, 2009). The operation of a computer vision system can be divided into three functions which is image acquisition and digitization, image processing and analysis, and interpretation. These functions and their relationships are illustrated schematically in Figure 1.1 (Groover, 2008).

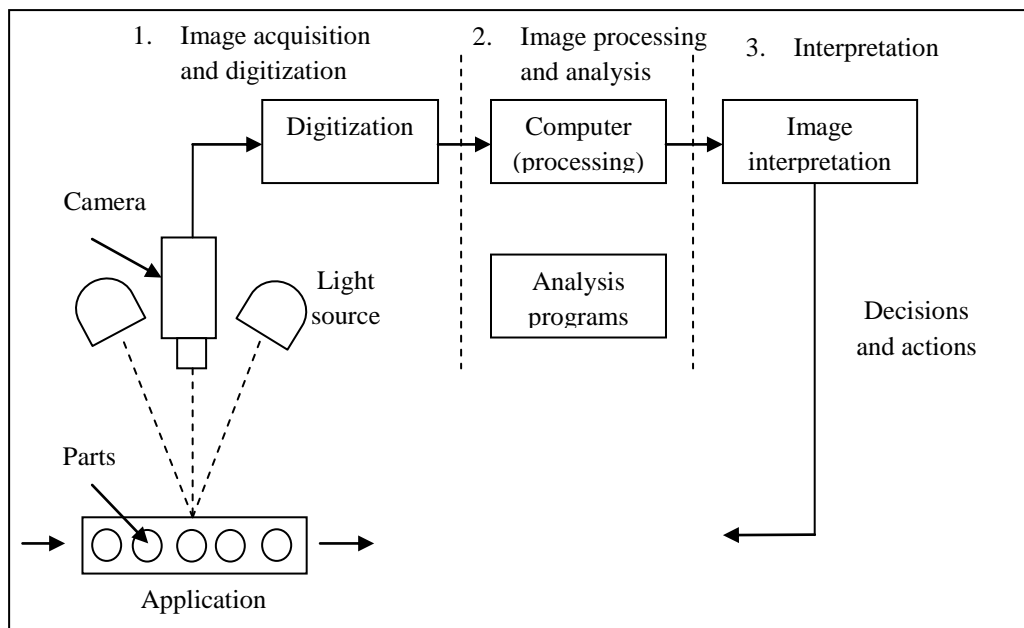


Figure 1.1: *Basic functions of a computer vision system.* (Groover, 2008)

Computer vision applications in manufacturing divide into three categories which is inspection, identification, and visual guidance and control. Computer vision installations in industry perform a variety of automated inspection tasks like dimensional measurement, dimensional gaging, verification of the presence of components, verification of hole location and number of holes, detection of surface flaws and defects and detection of flaws in a printed label. Visual guidance and control involves application in which a vision system is teamed with a robot or

similar machine to control the movement of the machine (Groover, 2008). Vision-guided robotic (VGR) system is used in connection with this technology (Zens, 2005).

The focus of this project is to acquire, analyze, recognize of objects, object interpretation, and develop an application. Systematic assembly and inspection is usually performed by the human workers. By using robot vision and image processing, it can implement the quality control and objects recognition to ensure that the quality of the product and its component meet the standards specified by the product designer. Artificial intelligence can implement in the robot by using interpretation.

1.2 Objective

The objectives or goals of this project are:

1. To perform image segmentation using edge detection, thresholding and color segmentation.
2. To develop algorithm for object recognition.
3. To develop graphical user interface (GUI) for image segmentation and object recognition using MATLAB.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Image Processing

Image processing is a processing of digital images using computer techniques such as analyzing, enhancing, compressing and reconstructing of image. The input of the image is captured through scanning or digital photography (image processing, 2009). Most image processing using techniques to processing image which is distinct as two-dimensional function, $f(x, y)$, where x and y are spatial (plane) coordinate (Gonzalez & Woods, 2008).

The steps in image processing are import image or directly from digital photography, analysis and manipulation of the image by accomplished using various specialized software application, and output of the image (image processing, 2009). The image processing steps is shown in Figure 2.1.

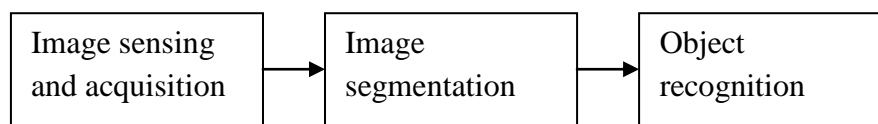


Figure 2.1: *Image processing steps.*

2.2 Image

An image is defined as a two-dimensional function, $f(x, y)$, where x and y are spatial (plane) coordinates. The intensity or gray level of the image at the point of coordinates (x, y) is the amplitude of f at any pair of coordinates (x, y) . Digital image is an image when x , y , and the intensity values of f are all finite, discrete quantities. Digital image is made up of a finite number of elements where each has a particular location and value. Picture elements, image elements, pels and pixels are the elements in digital image. Pixel is the most common term used to represent the elements of a digital image (Gonzalez & Woods, 2008).

2.2.1 RGB (Red, Green, Blue) Image

RGB image is based on a Cartesian coordinate system where each color appears in its primary spectral components of red, green, and blue. Figure 2.2 shows the color subspace of interest in the cube which RGB primary values are at three corners; the secondary colors cyan, magenta, and yellow are at three other corners; black is at the origin; and white is at the corner farthest from the origin. The gray scale (points of equal RGB values) extends from black to white along the line joining the origin and the farthest corner from the origin. The different colors in the RGB model are points on or inside the cube. They are defined by vectors extending from the origin. The cube shown in Figure 2.3 is the unit cube because all color values have been normalized for convenience where all values of R, G, and B are assumed to be in the range $[0, 1]$ (Gonzalez & Woods, 2008).

Pixel depth is the number of bits used to represent each pixel in RGB space. Each of the red, green, and blue images in an RGB image is an 8-bit image. Full-color image is used to denote a 24-bit RGB color image where the total number of colors in a 24-bit RGB image is $(2^8)^3 = 16,777,216$. Figure 2.4 shows the 24-bit RGB color cube. To view the colors in the RGB image is to generate color planes (faces or cross sections of the cube) is accomplished by fixing one of the three colors and allowing the other two to vary (Gonzalez & Woods, 2008).

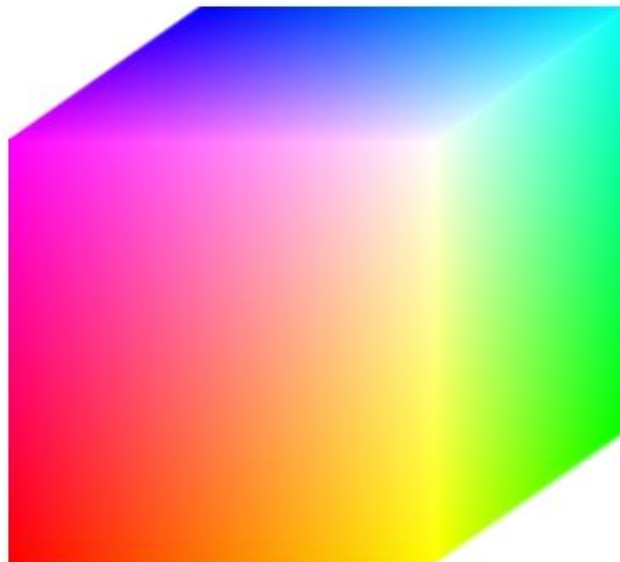


Figure 2.2: *RGB 24-bit color cube.* (Gonzalez & Woods, 2008)

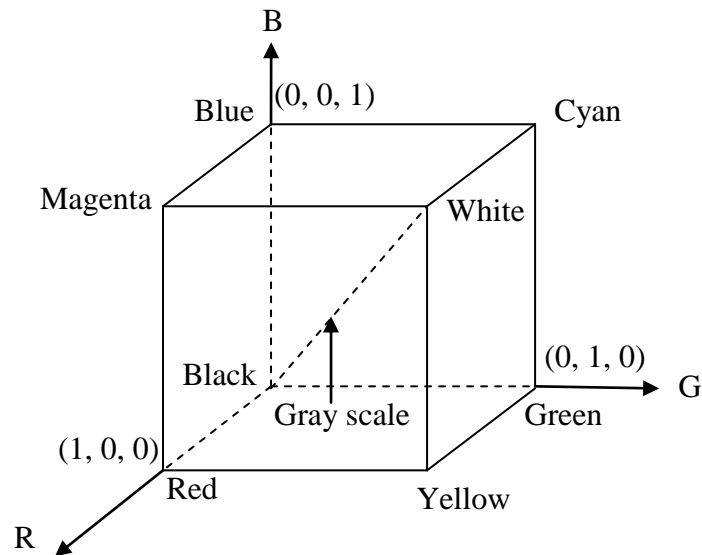


Figure 2.3: *Schematic of the RGB color cube. Points along the main diagonal have gray values, from black at the origin to white at point (1, 1, 1).* (Gonzalez & Woods, 2008).

2.2.2 Grayscale Image

Gray scale is the range of measured values of monochromatic light from black to white. Monochromatic light is the light that void of color and the attribute of monochromatic is its intensity or amount. Gray level is used to denote monochromatic intensity because the intensity of monochromatic light is perceived to vary from black to grays and finally white. The gray scale in the points of RGB values extends from black to white along the line joining the origin and the farthest corner from the origin. The basic operations for gray-scale morphology are dilation, erosion, opening, and closing (Gonzalez & Woods, 2008).