

VISION SYSTEM BASED HEIGHT MEASURING MACHINE

ROZEANA BINTI ABD RAHMAN

This report is submitted in partial fulfilment of the requirement for the award of
Bachelor of Electronic Engineering (Industrial Electronic) With Honours

Faculty of Electronic and Computer Engineering
University Technical Malaysia Melaka

April 2010



UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Vision System Based Height Measuring Machine
Sesi Pengajian :

0	9	/	1	0
---	---	---	---	---

Saya ROZEANA BINTI ABD RAHMAN

(HURUF BESAR)

mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan () :

SULIT*

*(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

TERHAD**

***(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

TIDAK TERHAD

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

Tarikh: 30April 2010

Tarikh:

“I hereby declare that this report is result of my own effort except for works that
have been cited clearly in the references.”

Signature :
Name : ROZEANA BINTI ABD RAHMAN
Date : 30/04/2010

“I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering (Electronic Telecommunication) with Honours”

Signature :
Supervisor’s Name : EN. KHAIRUL AZHA B. ABD. AZIZ
Date :

ACKNOWLEDGEMENTS

In the name of Allah, invocation and greetings to adoration of Nabi Muhammad (S.A.W.), thanks to God because giving me strength and patience in finishing. Final Year Project (Projek Sarjana Muda). Alhamdulillah.

In particular, I wish to express my sincere appreciation to my supervisor, Mr. En. Khairul Azha Bin A. Aziz, for encouragement, guidance, critics and friendship. My fellow friends under the same supervisor should also be recognized for their support and ideas.

I sincerely appreciated all of the efforts and precious time to be spent together in making this final year project educational, enjoyable and memorable. Not to be forgotten, my deepest thanks to my parents for all the support and blessings.

The great cooperation and kindheartedness to share worth experiences that have been shown by them will be always appreciated and treasured by me, thank you.

ABSTRACT

There are many of equipment designed to measure the height of an object. The equipment is divided by two which is in manual or automatic. Measuring in manual way takes long time and the value of measurement is not accurate. While for automatic way will increase the cost because the price so expensive. These problems can be overcome by using the vision system based height measuring machine which is user friendly and cost efficient. The objective of this project is to develop a system that can measure the height of the product using vision based system. The system will detect acquire the image of the product and display the height value on the screen. In this project the webcam is using to detect image or capture the image of product and it will interact with the Matlab software. The data will send into the based system. Image processing will run and define the height of object based on classification. Lastly the output will display on the computer screen.

ABSTRAK

Terdapat pelbagai peralatan yang dicipta untuk mengukur ketinggian sesuatu objek. Pengukuran yang dilakukan terbahagi kepada dua iaitu secara manual atau pun secara automatik dimana pengukuran dilakukan dengan menggunakan mesin. Biasanya pengukuran secara manual memerlukan masa yang lama dan bacaan yang diperolehi tidak tepat. Manakala pengukuran menggunakan mesin automatik memerlukan kos yang tinggi. Masalah ini boleh diatasi dengan menggunakan Mesin Pengukur Ketinggian Berasaskan Sistem Penglihatan. Ia mudah digunakan dan kos efisien. Sistem ini memerlukan pengaturcaraan Matlab untuk menjalankannya. Objektif projek ini adalah untuk membina satu sistem yang boleh mengukur ketinggian dengan menggunakan sistem penglihatan. Sistem ini boleh mengesan gambar produk dan memaparkan ukuran ketinggian objek di skrin komputer. Kamera digunakan untuk mengambil gambar produk dan berinteraksi dengan pengaturcaraan Matlab. Gambar akan dihantar ke pengaturcaraan Matlab untuk diproses. Gambar diproses mengikut klasifikasi yang telah ditetapkan di dalam sistem. Akhir sekali bacaan ketinggian yang diperolehi akan di paparkan di skrin komputer.

CONTENT

CHAPTER	TITLE	PAGE
	PROJECT TITLE	i
	VERIFICATION FORM STATUS REPORT	ii
	DECLARATION	iii
	SUPERVISOR VERIFICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
	CONTENTS	viii
	LIST OF FIGURE	xii
	LIST OF TABLE	xiii
I	INTRODUCTION	
	1.1 Introduction	1
	1.2 Project Objective	2
	1.3 Scope of Project	2
	1.4 Problem Statement	3
	1.5 Report Overview	3
II	LITERATURE REVIEW	
	2.1 Vision System	4

2.2	Machine Vision System	4
2.3	The advantages of Matlab	6
2.4	Image Processing	7
2.4.1	Image Processing in Matlab	7
2.4.1.1	Image conversion	8
2.4.1.2	Thresholding	9
2.4.1.3	Edge detector	11
2.4.1.4	Sobel edge detector	12
2.4.1.5	Morphological image processing	13
2.4.1.6	Arithmetic operation	14
2.4.1.7	Complement image	15
2.5	Height measuring method	16
2.5.1	Manual	16
2.5.2	Automatic	17
2.5.3	Comparison measuring in manual and automatic	19

III METHODOLOGY

3.1	Block diagram of the system	20
3.2	Flow chart of project	21
3.3	Design methodology	23
3.4	Software development	24
3.4.1	Command	24
3.4.2	Webcam interaction	24
3.4.3	Image acquisition	25
3.4.4	Image Conversion	26
3.4.5	Image Segmentation (Thresholding)	26
3.4.6	Edge detector	26
3.4.7	Morphological image processing	27
3.5	Measurement process	28

IV RESULT AND DISCUSSION

4.1	Experimentation analysis and result	30
4.1.1	Webcam interaction and image capturing	32
4.1.2	Wall size measurement in pixel value	33
4.1.3	Image processing and height measurement on the bottles plastic.	34
4.1.3.1	Image processing on the bottles	34
4.1.3.2	Height measurement on the bottle s	37
4.1.4	Image Processing and Height Measurement on Shoes Boxes	39
4.1.4.1	Image processing on the shoes box	39
4.1.4.2	Height measurement	41
4.1.5	Percentage error and percentage accuracy	43
4.2	Discussion	47

V CONCLUSION AND RECOMMENDATION

5.1	Conclusion of this project	49
5.2	Recommendation	50

REFERENCES	51
-------------------	-----------

APPENDIX	53
-----------------	-----------

LIST OF FIGURE

NO	TITLE	PAGE
2.1	Machine vision systems	6
2.2	RGB image to gray scale image	9
2.3	RGB image to black and white image	10
2.4	Edge image	11
2.5	Sobel filter	12
2.6	Complement image	15
2.7	Measuring by using Caliper	16
2.8	Measuring by using Height Gauge	16
2.9	Measuring by using stainless ruler	17
2.10	Coordinates Measuring Machine (CMM)	18
2.11	Camera and touch probe use for measuring	18
3.1	Block diagram vision system based height measuring machine	20
3.2	Flow Chat of Project	22
3.3	Design Methodology of Project	23
3.4	Image in Figure	25
3.5	The wall image processing	28
3.6	The size of wall in pixel value	29
3.7	The size of product in pixel value	29
4.1	Webcam interaction	32
4.2	Capturing Image	32
4.3	Image of wall	33

4.4	The wall size in pixel value	33
4.5	Image processing on Bottle A	34
4.6	Cropped the image (Bottle A)	35
4.7	Image processing on Bottle B	35
4.8	Cropped the image (Bottle B)	36
4.9	Image processing on Bottle C	36
4.10	The command for height measurement	37
4.11	The height value of Bottle A	37
4.12	The height value of Bottle B	38
4.13	The height value of Bottle C	38
4.14	The boxes image	39
4.15	Image processing in Matlab on Shoes Box A	39
4.16	Cropped the box image (Shoes box A)	40
4.17	Image processing in Matlab on Shoes Box B	40
4.18	Cropped the box image (Shoes box A)	41
4.19	The height value of Shoes Box A	41
4.20	The height value of Shoes Box B	42

LIST OF TABLE

NO	TITLE	PAGE
2.1	The image or graphics format	8
2.2	List rules for dilation and erosion	13
2.3	Arithmetic function	14
2.4	Comparison measuring in manual and automatic	19
4.1	List of the product	31
4.2	The actual and measurement height value of product	43
4.3	Percentage error and accuracy of height product	46

CHAPTER 1

INTRODUCTION

1.1 Introduction

In science, measurement is the process of obtaining the magnitude of a quantity, such as height, length or mass, relative to a unit of measurement, such as a meter or a kilogram. A measurement answers the general question as in how many miles, or millimeters, or gigahertz. As measurement is basically about counting, measurement is conducted in numbers and is quantitative, in comparison to other observations which may be made in words and are qualitative. The term measurement can also be used to refer to a specific result obtained from the measurement process. Since accurate measurement is essential in many fields, and since all measurements are necessarily approximations, a great deal of effort must be taken to make measurements as accurate as possible.

1.2 Project Objective

The objective of this project is to develop a system that can measure the height of the product using vision based system. The system will detect acquire the image of the product and display the length value on the screen. This project is to design a system which can process the image of product to measure the length of the product. The system will be developed using Matlab. Besides that, this project also able to:

- To apply Matlab programming for image processing.
- To apply and improve the knowledge about image processing which are widely used in so many analysis applications.

1.3 Scopes of Project

This project more focus on the software, Matlab software is uses to develop a system that can capture image of product, measure the height and display the value of measurement. Webcam used as a medium to capture an image of product where it will interact with Matlab software for image processing. The grayscale image is use as an input and the image format is jpeg or .jpg. The reference distance for this project is equal or less than one meter. It means the distance between webcam and the wall.

1.4 Problem Statement

In the market there is so much equipment to measure height, but to get the exact measurement is difficult. Many measurements have done manually by the operator. When the measurement is done manually, then there are the less accurate the reading. This is because there was an error operators take readings. Besides that the measurement have done manually causing wastage of time and energy to get a reading because the operator had to take accurate readings repeatedly. There are also operators who forget to criticize the readings taken. To make measurements automatically, there are also factories produce a large expense to buy the best machine to get accurate measurement readings. Vision System Based Height Measuring Machine is proposing to solve these problems. The system is friendly user and requires only webcam and Matlab software to drive the system.

1.5 Report Overview

The Vision System Based Height Measuring Machine report is a combination of 5 chapters that contains and elaborates specific topics such as the Introduction, Literature Review, Methodology, Results and Discussions, Conclusion and Further Development that can be applied in this project.

Chapter 1: Introduction of the project.

Chapter 2: Literature review for the development of the Vision System Based Height Measuring Machine.

Chapter 3: Methodology of the project.

Chapter 4: The project finding such as progress result and analysis of the image processing to measuring the height of product.

Chapter 5: Conclusion and further development of the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Vision System

A vision system is capable of magnifying their vision multiple times and may catch imperfections and flaws indiscernible to the human eye. A vision system can inspect at a much higher rate than human eyes and are more precise and consistent than the human workforce they often replace. A vision system is an inexpensive replacement for manpower and can be run constantly, twenty-four hours a day, seven days a week. Infrared light can also be utilized to view the interiors of products to check for quality [13].

2.2 Machine vision systems

Machine vision systems are a distinctive part of daily operations in many industries. The chief purposes of machine vision systems are automated inspection and measurement of items in a production environment. Machine vision system designers generate products that emulate human vision and make decisions based on the data they collect. As a non-contact visual measuring system, the rapid and accurate measurement of objects is possible. The machine vision systems themselves can vary greatly as far as components but generally consist of an integrated camera, image capture, processing, storage, analysis and control scheme. Top machine vision

system designers are able to craft equipment that works 24 hours a day and seven days a week, with very little need for service or other downtime [13].

Since there is a wide range of technologies used in machine vision systems, the way they work also varies depending on the type of technology. At the most basic level, a camera or other image-capturing device monitors, records and reacts to a preset template of conditions given via a computer program. When the items that pass before the capture device deviate from the template and the preset measurements are recognized, the system or user is notified of the discrepancy. This is a key quality control feature in machine vision systems. Other machine vision systems are mostly used for visualization and image capture, which records a two dimensional image of an item within itself for later three dimensional virtual compositing. A typical machine vision system will consist of several among the following components:

1. One or more digital or analog camera (black-and-white or color) with suitable optics for acquiring images
2. Camera interface for digitizing images (widely known as a "frame grabber")
3. A processor (often a PC or embedded processor, such as a DSP)
4. (In some cases, the entire above are combined within a single device, called a smart camera).
5. Input/output hardware (e.g. digital I/O) or communication links (e.g. network connection or RS-232) to report results
6. Lenses to focus the desired field of view onto the image sensor.
7. Suitable, often very specialized, light sources (LED illuminators, fluorescent or halogen lamps etc.)
8. Program to process images and detect relevant features.
9. A synchronizing sensor for part detection (often an optical or magnetic sensor) to trigger image acquisition and processing.
10. Some form of actuators used to sort or reject defective parts.

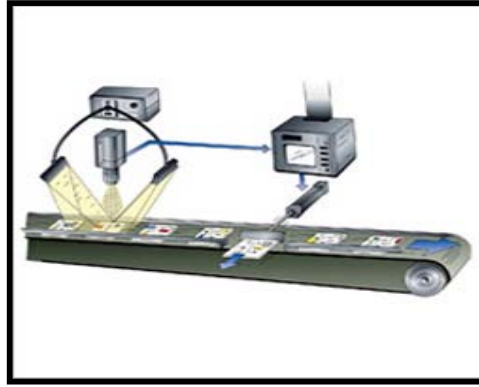


Figure 2.1: Machine vision systems

2.3 The Advantages of MATLAB

MATLAB is a general purpose programming language. When it is used to process images one generally writes function files, or script files to perform the operations. These files form a formal record of the processing used and ensures that the final results can be tested and *replicated* by others should the need arise. MATLAB allows its users to accurately solve problems, produce graphics easily and produce code efficiently [18].

MATLAB provides many functions for image processing and other tasks. Most of these functions are written in the MATLAB language and are publicly readable as plain text files. Thus the implementation details of these functions are accessible and open to scrutiny. The defense can examine the processing used in complete detail, and any challenges raised can be responded to in an informed way by the prosecution [18].

Another advantage of MATLAB is an interpreted language for numerical computation. It allows one to perform numerical calculations, and visualize the results without the need for complicated and time consuming programming. In general, image files store data to 8 bit precision. This corresponds to a range of integer values from 0-255. A pixel in a color image may be represented by three 8 bit numbers, each representing the red(R), green (G) and blue (B) components as an integer value between 0 and 255 [18].

MATLAB is a scientific programming language and provides strong mathematical and numerical support for the implementation of advanced algorithms. It is for this reason that MATLAB is widely used by the image processing and computer vision community. New algorithms are very likely to be implemented first in MATLAB; indeed they may only be available in MATLAB [18].

2.4 Image Processing

Image processing generally involves extraction of useful information from an image. This very useful information may be the dimensions of an engineering component, size of diagnosed tumor, or even a 3D view of an unborn baby. In Pakistan the main areas of application of image processing are bio-medical, engineering and quality control [15].

2.4.1 Image Processing in Matlab

In Matlab the image can be conveniently represented as matrices. The image can be open as a matrix by using `imread` command. The matrix may simply be $m \times n$ form or it may be 3 dimensional arrays or it may be an indexed matrix, depending upon image type. The image processing may be done simply by matrix calculation or matrix manipulation. The image is displayed with `imshow` command and the changes image can be saved with `imwrite` command [15]. Images also read into Matlab environment using function `imread`. Table below was shown some of the image or graphics formats supported by `imread` and `imwrite` [3].

Format Name	Description	Recognized Extensions
TIFF	Tagged Image File Format	.tif, .tiff
JPEG	Joint Photographic Experts Group	.jpg, .jpeg
GIF	Graphics Interchange Format	.gif
BMP	Windows Bitmap	.bmp
PNG	Portable Network Graphics	.png
XWD	X Window Dump	.xwd

Table 2.1: The image or graphics format

2.4.1.1 Image Conversion

Gray scale image is represents an image as a matrix where every element has a value corresponding to how bright/dark the pixel at the corresponding position should be colored. There are two ways to represent the number that represents the brightness of the pixel: The double class (or data type). This assigns a floating number ("a number with decimals") between 0 and 1 to each pixel. The value 0 corresponds to black and the value 1 corresponds to white. The other class is called uint8 which assigns an integer between 0 and 255 to represent the brightness of a pixel. The value 0 corresponds to black and 255 to white. The class uint8 only requires roughly 1/8 of the storage compared to the class double. On the other hand, many mathematical functions can only be applied to the double class.

$I = \text{rgb2gray}(\text{RGB})$ converts the truecolor image RGB to the grayscale intensity image I. `rgb2gray` converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance [14].

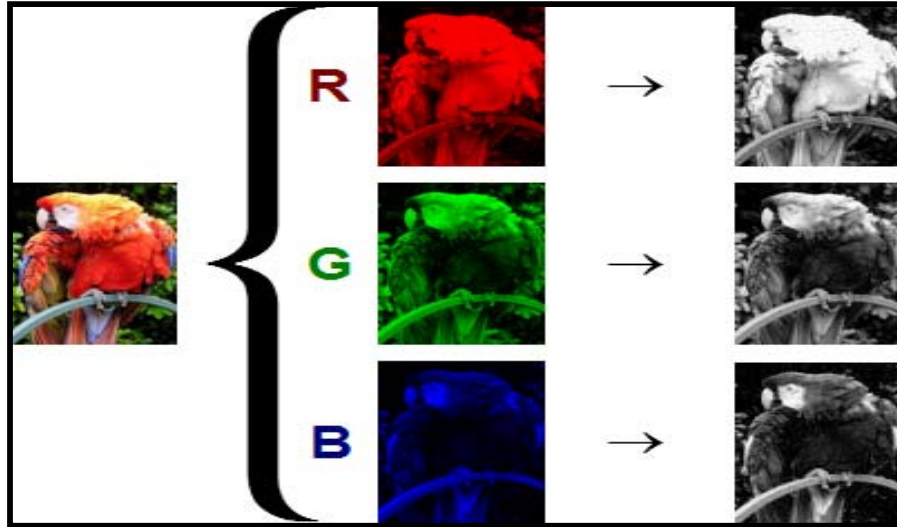


Figure 2.2: RGB image to gray scale image

2.4.1.2 Thresholding

$\text{BW} = \text{im2bw}(I, \text{level})$ converts the grayscale image I to a binary image. The output image BW replaces all pixels in the input image with luminance greater than level with the value 1 (white) and replaces all other pixels with the value 0 (black). Specify level in the range [0,1], regardless of the class of the input image [14]. During the thresholding process, individual pixels in an image are marked as “object” pixels if their value is greater than some threshold value (assuming an object to be brighter than the background) and as “background” pixels otherwise. This convention is known as threshold above. Variants include threshold below, which is opposite of threshold above; threshold inside, where a pixel is labeled "object" if its value is between two thresholds; and threshold outside, which is the opposite of threshold inside. Typically, an object pixel is given a value of “1” while a background pixel is given a value of “0.” Finally, a binary image is created by coloring each pixel white or black, depending on a pixel's label.

Categorizing Thresholding Methods are:

- **histogram shape** based methods, where, for example, the peaks, valleys and curvatures of the smoothed histogram are analyzed
- **Clustering** based methods, where the gray-level samples are clustered in two parts as background and foreground (object), or alternately are modeled as a mixture of two Gaussians
- **Entropy** based methods result in algorithms that use the entropy of the foreground and background regions, the cross-entropy between the original and binarized image, etc.
- **Object attribute**-based methods search a measure of similarity between the gray-level and the binaries images, such as fuzzy shape similarity, edge coincidence, etc.
- [...] **spatial** methods [that] use higher-order probability distribution and/or correlation between pixels
- **Local** methods adapt the threshold value on each pixel to the local image characteristics."



Figure 2.3: RGB image to black and white image

2.4.1.3 Edge Detection

Edges are considered to be most important image attributes that provide valuable information for human image perception. With the advent of artificial intelligence systems and forensic science the process of edge detection has achieved the most sought status. Edge detection is a very complex process affected by deterioration due to different level of noise. A number of operators are defined to solve the problem of edge detection. [1–6].

In early processes, the edge detection was mainly performed on software due to its large hardware requirement and also the application-specific integrated circuits have not gain much advancement. But present researches on programmable devices make it possible to implement edge detection algorithms on these devices whose design turn-around time varies from few hours to few days.[10]

Edge detection is the process of locating the edge pixels. Then an edge enhancement will increase the contrast between the edges and the background in such a way that edges become more visible [9]. Edge supports six different edge-finding methods which is Sobel, Prewitt, Roberts, Laplacian of Gaussian, Zero-cross and Canny method [2]. This edge function looks for places in the image where the intensity changes rapidly, using one of these two criteria:

- Places where the first derivative of the intensity is larger in magnitude than some threshold.
- Places where the second derivative of the intensity has a zero crossing.

Example:

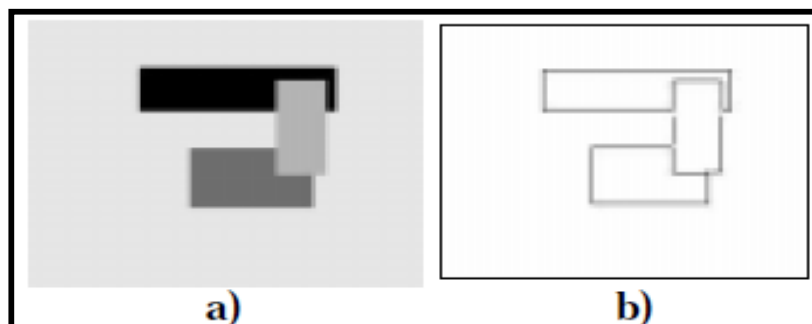


Figure 2.4: Edge image