VISION SYSTEM BASED HEIGHT MEASURING MACHINE

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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

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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.
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.
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].

Figure 2.1: Machine vision systems
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 x n form or it may be 3 dimentional 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].
<table>
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<th>Format Name</th>
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<th>Recognized Extensions</th>
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<tr>
<td>JPEG</td>
<td>Joint Photographic Experts Group</td>
<td>.jpg, .jpeg</td>
</tr>
<tr>
<td>GIF</td>
<td>Graphics Interchange Format</td>
<td>.gif</td>
</tr>
<tr>
<td>BMP</td>
<td>Windows Bitmap</td>
<td>.bmp</td>
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<tr>
<td>PNG</td>
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<tr>
<td>XWD</td>
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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 = rgb2gray(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].

![RGB to Gray Scale Image](image)

Figure 2.2: RGB image to gray scale image

### 2.4.1.2 Thresholding

BW = im2bw(I, 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](image-url)
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