UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZATION OF MEASUREMENT PARAMETERS IN NON-CONTACT MEASURING SYSTEM

This report submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process) with Honours.

by

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FACULTY OF MANUFACTURING ENGINEERING
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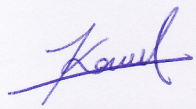
Signature	:	
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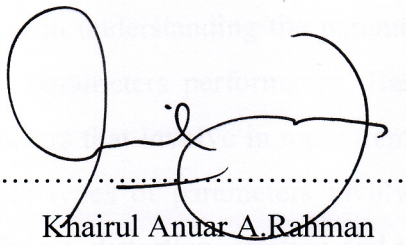

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ABSTRACT

In non contact measuring system, optimizing the parameters is a one of the most important role that may affect the results of measurement. Based on the necessity, this study is conducted. The purpose of this study is to optimize the measurement parameters in Charge Couple Device (CCD) camera. This study also being carried out to perform an analysis of the camera calibration data and at the mean time, optimizing the parameter required for CCD camera. This study will begin with the introduction and understanding of the title, objectives and problem statement that been faced in measured product. In literature review section, student will review about methods of calibration in understanding the parameters that will be used and other influences that affect parameters performance. Based on the information in literature review, the parameters that involve in measurement by using CCD camera will be listed. There are six types of parameters involve which are focal length, principal point, skew coefficient, distortion, rotation and translation. Based on result and analysis, parameters optimization depends on the distance between object and camera, also position of the object. An addition, in optimization of CCD camera parameters, lighting systems also should be considered.

ABSTRAK

Dalam sistem pengukuran berskala tanpa sentuh, parameter memainkan peranan penting kerana ia memberi kesan terhadap hasil pengukuran. Berdasarkan kepentingan tersebut, kajian ini dijalankan. Tujuan kajian ini ialah untuk mengoptimumkan parameter pengukuran mengunakan kamera CCD. Kajian ini juga dijalankan bagi menghasilkan satu analisis daripada data pengukuran kamera dan pada masa yang sama, mengoptimumkan parameter yang diperlukan oleh kamera CCD. Kajian ini bermula dengan pengenalan dan pemahaman tajuk kajian, objektif kajian dan masalah yang sedia ada dalam pengukuran produk. Seterusnya, pelajar akan mengkaji mengenai kaedah-kaedah pengukuran parameter yang akan digunakan dan pengaruh lain yang menjejaskan parameter. Berdasarkan maklumat-maklumat tersebut, parameter yang melibatkan kamera CCD akan disenaraikan. Parameter yang terlibat adalah 'focal length', 'principal point', 'skew coefficient', 'distortion' 'rotation' dan 'translation'. Daripada keputusan yang dihasilkan dan analisis, optimum sesuatu parameter bergantung kepada jarak objek dan kamera, serta kedudukan objek. Sebagai tambahan, dalam mengoptimumkan parameter kamera CCD, sistem pencahayaan turut memainkan diambil perhation.

DEDICATION

To my beloved family, my respectful supervisor and examiner, my fellow friends and all the parties involved, thank you so much.

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Mohd Kamarul Nizam Bin Abdul Hamid

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LIST OF ABBREVIATIONS, SYMBOLS, NOMENCLATURES

ANOVA	–	Analysis of Variance
CCD	–	Charge Couple Device
DOE	–	Design of Experiment
PSM	–	Projek Sarjana Muda
SPSS	–	Statistical Package for the Social Sciences

CHAPTER 1
INTRODUCTION

.1 Overview

Nowadays, there are many of company have been established in industrial field. From a small and medium industry company till giant industry company produce their own products. Each of the products produced have their own size and shape, usually based on customers demand. After the product had been producing, they will have a quality inspection which the products will be inspect detail to ensure the products are meet the customer requirements. The quality inspections will emphasize the size of the products, defects, functionality, etc. Measuring a product plays one of the important roles to ensure products in specification value range and fulfill customer requirements.

To obtain an accurate product and reduce rejected amount of product, many measurement techniques have been thoroughly investigated. Those measurement techniques that been applied commonly are using rulers, vernier caliper, gauges, micrometers and sensors. Normally the equipments and techniques that been used depend on the geometry of product that will be calibrate. For the product which is complex geometry, the use of dimensional measurements to reconstruct object geometry becomes a complicated metrology problem. Based of this, dimensional measurement methods that would solve complicated metrology problems are explored.

.2 Problem Statement

For measurement inspection, there are several types of metrology that been applied. The selection of the metrology or techniques of measurement depend on the product geometry. A techniques used to calibrate a machine part will be different from the techniques used to calibrate electronic parts. In calibrating a machine parts such as hand break for example, usually will used sampling method. But this method can't be applied to calibrate an electrical or electronic component product. This is because those components had a critical section which is the dimension and defects can't be seen outer portion and need to be inspecting more details. By using the CCD camera, the geometry defects either wear or dimension of the products can be detected clearly. Even though these CCD cameras is still new for part inspection in the manufacturing industry but by applying this technology, manufacturing company may save more cost and improve quality of product. In measuring system that using CCD camera, parameters are important to produce good measurement result. The problem here is how to optimize the parameters in measuring system that using CCD camera.

Based on this, a study will be doing and the study focused on optimization of measurement parameters in non-contact measuring system so that more effectiveness quality of geometry checking can be produce.

.3 Objective

Those are the objectives of this study and based from the objectives, student may accomplish the study.

i. To determine the most suitable parameters to be applied in non-contact measuring system.
ii. Define how to optimize these parameters while in operation.
iii. Also define the influence that will affect the parameters.
iv. Analyze whether the parameters that been selected really been optimize.

.4 Scope of Project

This study focuses on parameters optimization which is one of the most important topics in developing a non-contact measuring system. The parameters that related with CCD camera should be selected carefully because its will affect measuring result. So, it's very important to define whether parameters are suitable or not to be applied in this study. Generally there are several types of parameters, but this study is more focus on the two main parameter; intrinsic and extrinsic. These parameters also need to be optimized so that the measurement that been produce are optimum. Besides that, factor of influences and affect the image results also considered in this study.

.5 Project Outline

i. Chapter 1 describes the introduction of the project, problem statement, objective and scope of the study. Problem statement is necessary to conduct optimization of parameters in non contact measuring system (CCD camera).
ii. Chapter 2 explained literature review related to the study which includes description on CCD camera, the parameters involve in CCD camera and others influence that may affect camera parameters.
iii. Chapter 3 defined the methodology in parameters optimization and briefly explanation of the each process.
iv. Chapter 4 consists of the project implementation for the experiments carried out.
v. Chapter 5 consists of the result and analysis towards the experiments carried out.
vi. Chapter 6 construct by the discussion of the analysis gathered on the experimental process.
vii. Chapter 7 concludes the project did and recommends for future improvements.

CHAPTER 2
LITERATURE RIVIEW

2.1 Introduction

This chapter will describe about charge couple device (CCD) camera and related sources of the research had been done by others persons in optimize the camera parameters. It's able to help in understanding about CCD camera and as starting references of this study because these camera parameters will be applied in camera calibration. So, in this chapter will review about CCD camera and other influences.

2.2 Background

Nowadays, many types of cameras had been produced and usually a camera selected based on its function and qualities. Before become a complex camera in this day, these camera fields actually had many evolutions. Then charge coupled device (CCD) developed and this applied in produce charge coupled device (CCD) camera, new generation camera. Historically, the CCD technology was invented in 1969 by Willard Boyle and George E. Smith at AT&T Bell Labs. Then, Boyle and Smith conceived of the design of what they termed 'Charge "Bubble" Devices'. The essence of the design was the ability to transfer charge along surface of a semiconductor. However, it was immediately clear that the CCD could receive charge via the photoelectric effect and electronic images could be created. On years 1970, Bell researchers were able to capture images with simple linear devices which is thus the CCD was born Brooke, B. (2008). The use of a solid state chip sensor make the camera 100% solid state offering significant advantages over all tube cameras such as:

(a) Longer life
(b) No aging
(c) No image burn-in
(d) Geometric accuracy
(e) Excellent sensitivity
(f) Excellent resolution

2.2.1 Types of CCD Camera

Classification of a camera depends on its application. The speed factor make the cameras divide in three types which on-line, fast camera and slow scan camera. An on-line camera takes 50 to 60 frames per second. Normally general-purpose of this types cameras are used in security and videography. The image can be displayed on a video monitor or a TV with video input facility. An on-line camera has auto iris lens facility. Meanwhile for a fast camera, its takes 1 to 10 million frames per second. These cameras have special application in ballistic missiles. For slow scan cameras, it been used only in scientific imaging like astronomy and medical application where the object is very faint. Slow scan CCD cameras are generally used with electronic shutters in which the opening of the shutter can be controlled during exposure (integration) time, and the image is read out from the detector after closing the shutter Peter, G. (1992).

Meanwhile, the CCD camera output can be divided in three categories which are composite video, separate RGB, and digital output. Composite video is a general-purpose black-and-white camera facility, and almost every commercially camera provides this output. Colour camera gives separate RGB output. Colour CCD camera has a special CCD detector. It requires higher light level as compared to the black-and-white camera. Digital output is a special facility or a digital camera in which CCD video output can be displayed in grey levels of 8 or 16 bits with the help of display cards Peter, G. (1992).

2.2.2 Application of CCD camera

CCD camera plays important roles in non contact measuring system. The system which using CCD camera in calibration may be applied in many types of industrial field. This is because by using CCD camera in calibration products, more details results of condition of the product will receive. Below are the some examples of the functions of CCD camera while applied in industries:

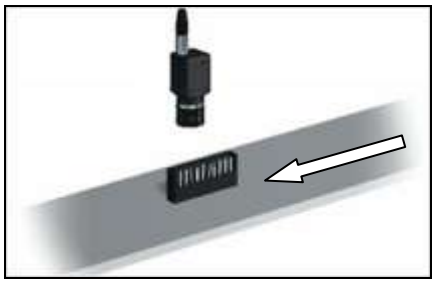

Figure 2.1: Measuring the coplanarity of connector pins (Dimension Measurement) Anonymous (2008a).

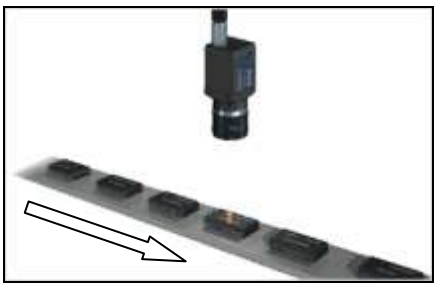

Figure 2.2: Detecting "reject" marks on electronic components (Presence/Absence detection) Anonymous (2008a).

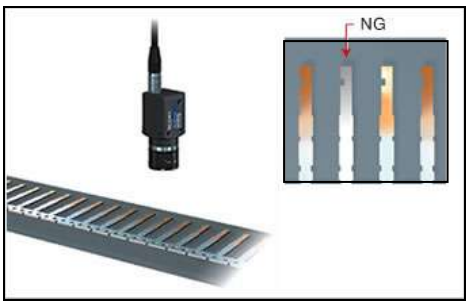

Figure 2.3: Detecting defective pin plating (Presence/Absence detection) Anonymous (2008a).

2.2.3 Image processing

In a CCD for capturing images, there is a photoactive region (an epitaxial layer of silicon), and a transmission region made out of a shift register (the CCD, properly speaking). An image is projected by a lens on the capacitor array (the photoactive region), causing each capacitor to accumulate an electric charge proportional to the light intensity at that location. A one-dimensional array, used in line-scan cameras, captures a single slice of the image, while a two-dimensional array, used in video and still cameras, captures a two-dimensional picture corresponding to the scene projected onto the focal plane of the sensor. Once the array has been exposed to the image, a control circuit causes each capacitor to transfer its contents to its neighbor. The last capacitor in the array dumps its charge into a charge amplifier, which converts the charge into a voltage. By repeating this process, the controlling circuit converts the entire semiconductor contents of the array to a sequence of voltages, which it samples, digitizes and stores in some form of memory Anonymous (2007b).

2.3 Parameters

Parameter is origin from Greek words which is para means beside and metron means measure. Parameter can be define as a measurable or quantifiable characteristic of a system, a quantity which is fixed for the case in question but may vary in other cases or a limit or boundary which defines the scope of a process or activity Anonymous (2008c). Based on the definition, CCD parameter means measurable or quantifiable characteristic of a CCD camera system.

2.3.1 Types Of Parameters Generally

There are several types of parameters which been define by different source and research. This part will view generally about these parameters. There are two sets of parameters for a CCD camera which are intrinsic parameters, and extrinsic parameters Kenneth R. (2008). Meanwhile other researcher told that the intrinsic parameters can be distinguished into two subsets. The first set includes the effective

focal length, the coordinates of the principal point, and the pixel aspect ratio of the CCD camera. He also noticed that for the determination of the external geometry of a CCD camera has to estimate the 3-D rigid transformation which relates the 3-D reference system associated with the camera (camera coordinate system (CCS)) with the 3-D reference system associated with the imaged scene (object coordinate system (OCS)). This transformation has six degrees of freedom: the three components of the translational displacement and the three degrees of freedom of the rotation matrix Sundaresan, A. (2003). The parameters are the shutter, gain, offset, hue, sharpness, gamma, saturation, and auto exposure. Shutter is to determines the CCD‘s exposure time, gain determines the amplification of the CCD output signal, the offset is added to the CCD‘s output signal, auto exposure determines whether the adjustment of the exposure time and the gain is to be adjusted manually or automatically, sharpness which to use this mechanism to enhance blurred images, gamma increases or decreases the middle graylevels, saturation to adjust the color‘s saturation from monochrome to high color values, hue to shift color values and white balance which is to vary the degree of red and blue in the image to achieve a lifelike color representation Lucchese, C. (2005). Other journal define that, known target coordinates are not necessary. If the geometry of the photogrammetric network is well designed and only the primary physical calibration parameters (principal point, principal distance, lens distortions, image orthogonality and image affinity) are desired then the situation reverts to a self calibration Nazki, J. (2005).

2.3.2 Main Parameters

This section will review the sources that told that there are two main types of parameters which are extrinsic and intrinsic parameters. This journal said that extrinsic parameters of a camera represent the rigid body transformation between the world coordinate system (centered at o) and the camera coordinate system (centered at c). Meanwhile intrinsic parameters represent the camera internal parameters like focal length, aspect ratio, skew, and principal point. Figure 2.0 show the figure of parameters that involve in camera Mark, R. and Walter, L. (1995).