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FINAL YEAR PROJECT REPORT

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I hereby declare that I have read through this report entitle "Quality Checking and Inspection Using Machine Vision Technique" and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Mechatronics Engineering.

Signature : ……

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QUALITY CHECKING AND INSPECTION USING MACHINE VISION TECHNIQUE

WONG GAO JIE

A report submitted in partial fulfilment of the requirements for the degree of Bachelor of Mechatronics Engineering

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2016

I declare that this report entitle “Quality Checking and Inspection Using Machine Vision Technique” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : ……

Date : ……

To my beloved mother and father

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ABSTRACT

The development of algorithm for inspection and quality check using machine vision is being discussed where the design of the algorithm is to detect the sign of defect when a sample of product is used for inspection purposes. It is also designed to track specific color of product and conduct the inspection process. Programming language of python and open source computer vision library were used to design the inspection algorithm based on the algorithm required to achieve the inspection task. Illumination and surrounding environment were considered during the design as it may affect the quality of image acquisitioned by image sensor. Experiment and set-up by using CMOS image sensor were conducted to test the designed algorithm for effectiveness evaluation. The experimental results were obtained and is represented in graphical form for further analysis purposes. Besides, analysis and discussion were made based on the obtained results through the experiments. The designed algorithm is able to perform the inspection by sample object detection and differentiate between good and defect unit.

ABSTRAK

Pembinaan algoritma demi proses inspeksi dan memeriksa melalui teknik penglihatan mesin telah dibincangkan. Algoritma tersebut mempunyai fungsi tujuannya untuk mengesan kerosakan sesuatu produk berdasarkan. Bahasa pengaturcaraan Python serta pengaturcaraan untuk penglihat mesin (OpenCV) telah digunakan bagi membina algoritma tersebut berdasarkan algoritma supaya ia dapat menjalankan tugas mengesan sesuatu unit produk. Cahaya dan keadaan persekitaran juga dipertimbangkan ketika membuat eksperimentasi terhadap algoritma maka ia mungkin menjejaskan kualiti imej melalui imej sensor. Eksperimen dengan menggunakan penderia imej CMOS telah dilakukan untuk mencuba dan menilaikan reka algoritma tersebut serta mendapatkan keputusan. Keputusan terdapat melalui eksperimentasi telah direkodkan dalam bentuk graf. Selain itu, proses analisasi dan perbincangan bagi keputusan yang terdapat melalui eksperimen telah dibincangkan seperti berikut. Melalui algoritma tersebut, maka ia dapat mengesan dan membezakan antara unit produk yang baik atau tidak seperti yang dijangkakan.

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CHAPTER 1

INTRODUCTION

The following section of this chapter highlights the overview of quality checking and inspection using machine vision technique which involves the design and development of proposed algorithm that can be used to detect and determine any sign of defect through the process of reading the pixels and extract details from the digital image acquisitioned by image sensor.

1.1 Motivation

In the manufacturing plantation, numbers of company employ quality control inspector to perform product inspection checking which it requires human's physical ability to ensure the product is within the acceptable range and reject any defective unit before being packed and delivered to customer. Normally, quality control inspector worked about two hours a day to do the required inspection on lots of parts and it take full eight hours to inspect each unit of product separately[1]. However, labours tends to fatigues after period of working hours results in degrade performance during inspection process[2]. Human's eye are limited to vision system that enable us from seeing object that can be reflected by illumination and to recognize the size, shape and colour of object. However, a person who suffer from colour disorder may face difficulty in distinguishing between colours in vision inspection[3].

The existence of human's error tends to cause some mistake in quality checking may lead to dissatisfaction of customers[4]. In the scenario of quality checking in automobile industry, any minor scratch or damage of chassis must be marked down and record in the pre-delivery inspection paper before the vehicle is delivered. Somehow if the technician who conduct the pre-delivery checking fail to detect any sign of defection due to human's eye constraints and surrounding illumination may results in causing trouble to the company. In real life situation, inspection process usually has to be fast enough and accurate to avoid production delay happens in manufacturing plantation which can affects the productivity rate. Inspection of human's eye over a period of time without pausing, blinks or enough rest may cause eye strains and it reduce the ability to concentrate[5]. Therefore, machine vision inspection system using well designed technology with good image processing and algorithm is required to aid human's visual inspection in manufacturing process.

1.2 Problem Statement

The fundamental implementation of machine vision comprise of vision camera, computer host, illumination effects and others[6]. Based on the technology used in machine vision application, there are several constraints that a machine need to be improved. A good inspection system require well designed and high performance in visual system and image analysing process. However, there are several constraints and limitation of machine vision in application of inspection process. One of the criteria includes illumination which is the lighting effect on certain object can affect the image quality captured by machine vision with the aid of camera sensors[7]. Quality of captured image with respect to camera speed in frame per second depends on surrounding illumination while the machine vision is used for product checking. However, if the frame per second of camera is doubled then it will require two times the normal surrounding illumination in order to produce sharp and clear image for image analysis process. Failure to do so can affect the performance of machine vision during the inspection process[8].

Another criteria for the inspection that need to be concerned in machine vision is programming which it is used for image analysis or processing purposes during the inspection process. For a machine vision in an inspection process, the image captured by camera will be analysed by using a software typically by open source computer vision library with algorithm to compare and differentiate between good unit and defective unit. Different software algorithm will be designed depends on the need and requirement as well as the purpose in the industry for quality checking and controlling. Some algorithm used in machine vision may cause some delay or error during image analysis and do not act immediately if defective unit occur leading to technical error happens[9].

Hence, a suitable design in illumination system with respect to the frame per second of camera is required to optimize the image produced by camera. In addition, the programming for detection algorithm for inspection need to be implemented in such the way that the algorithm can perform well in an inspection process.

Therefore, this research develops and designs an algorithm for inspection process by using machine vision system with the consideration of improvement and optimize in the

application of illumination and detection algorithm (programming) for image processing and analysis purposes in an inspection process.

1.3 Objectives

The objectives of the project are:

1. To develop algorithm for detection of defective white ceramic cup.
2. To develop intelligent system that able to track specific colour of product.
3. To evaluate system performance based on quality and inspection checking.

1.4 Scopes

The scopes of the research are listed as follow:

1. The position of camera must mounted on rigid body or holder and is static.
2. The algorithm developed is take into account of surrounding light intensity and shadow of the object that might cause difficulty to detect.
3. The algorithm limits to check at only one ceramic product at a time.
4. The white ceramic cup must enter fully into the resolution or frame of camera for inspection process.
5. The performance of real time process constraints are subjected to surrounding illumination and field of application.
6. The algorithm is only be apply on manufacturing process.
7. The product must be placed on a flat surface with its background of black colour.
8. Distance between camera and product is fixed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

High technology inspection systems are implemented in modern industry and manufacturing process to replace with labor inspection that may cause technical issues or error due to mankind physical constraints as mentioned by[3]. Machine vision inspection system however, is a well-known compulsory system for almost every industry. There are numbers of method used in the modern industry depends on the requirement of inspection. Different manufacturing process typically need a specially designed machine vision for high performance in the inspection process with least expenses on their inspection system.

Generally, the review of literature discusses about the method studied by number of authors who implemented the design in detection and inspection process. Different design has their own unique way or algorithm in the inspection process. In order to develop an algorithm for defect detection and inspection, analysis of different journal paper is important to determine each method used in different area of inspection. Some inspection typically need visual system which is similar to how human's eye observe as[6] but different situation contradict to other type of inspection like X-ray scanning. Meanwhile, X-ray scanning method can be used to detect and observe the internal structure rather than outer look of a product as[10]. A good quality product require checking in many different aspects like internally checking and externally checking.

Internal checking usually involves in food industry where it is required to see if the food is packed correctly in place or position, the amount of food or contains to fulfil the production requirement. Whereas externally typically involves the packaging and printing on a product if is there any damages or printing error occur. Thus, many different criteria of an inspection process has been discussed as in the follows.

2.1.1 History of Machine Vision System

Machine vision was originated from computer vision system, also known as the method for acquiring, processing, analyzing as well as understand the images. Back in the early 1960s, computer vision system has been introduced and experienced the growth of its application over the year. This computer vision system has been used in various field of study as it has become one of the handful system to ease the study and provides beneficial information. The term computer vision is synonymous to machine vision with embodies several process[6].

2.2 Background of Machine Vision System

This computer vision system also known as the construction of explicit and meaningful description of physical objects from images [11]. Often thought both computer vision and machine vision to be one in the same but they are both different in terms of technologies. Computer vision refers in broad term to the capture and automation of image analysis whereas machine vision refers to the use of computer vision to factory automation. In the early century, manufacturing process and plantations often use human eye or labors for inspection of every product until lately both the computer and light sensory device has been introduced to the public. People then started to use computer and sensory device for image analysis and processing to try to imitate human inspection and replace labor with computer vision system. This can avoid human errors and improve the productivity of certain product as it can be operate in 24 hours per day with the source of electricity.

Due to evolutionary of computer and technologies, software and programming has become one of the important part in vision system that promotes to create series of computer programming library such as OpenCV, Scikit , Numpy and others that aimed at the real time based computer vision. While other framework designed to support the programming library for building computer vision application. Somehow, these framework require machine middle level programming language such as C#, C++, python and other supported API for instruction and command.

2.3 Image Sensor

A digital image is the image that is captured and represented by the image sensor which is widely used in many different field or applications such as electronic devices, security, medical vision and others. There are two type of sensor that is commonly used nowadays which are CCD and CMOS. CCD also known as charge-coupled device image sensor whereas CMOS is called complementary metal oxide semiconductor image sensor. Both the sensors are pixelated metal oxide semiconductors which is designed to accumulate signal charge and transfer the data to control system. The following section briefly discusses about each type of image sensor with its respective performances.

2.3.1 Charge-coupled Device (CCD) Sensor

This kind of sensor generates image which is in pixel via pixel's charge packet when the sensor has been exposed to local illumination. Once the pixel is being exposed to illumination, CCD will then transfers each pixel's packet sequentially to a common output structure and converts the charge to a voltage. The figure below shows the overview of system structure for CCD sensor[12].

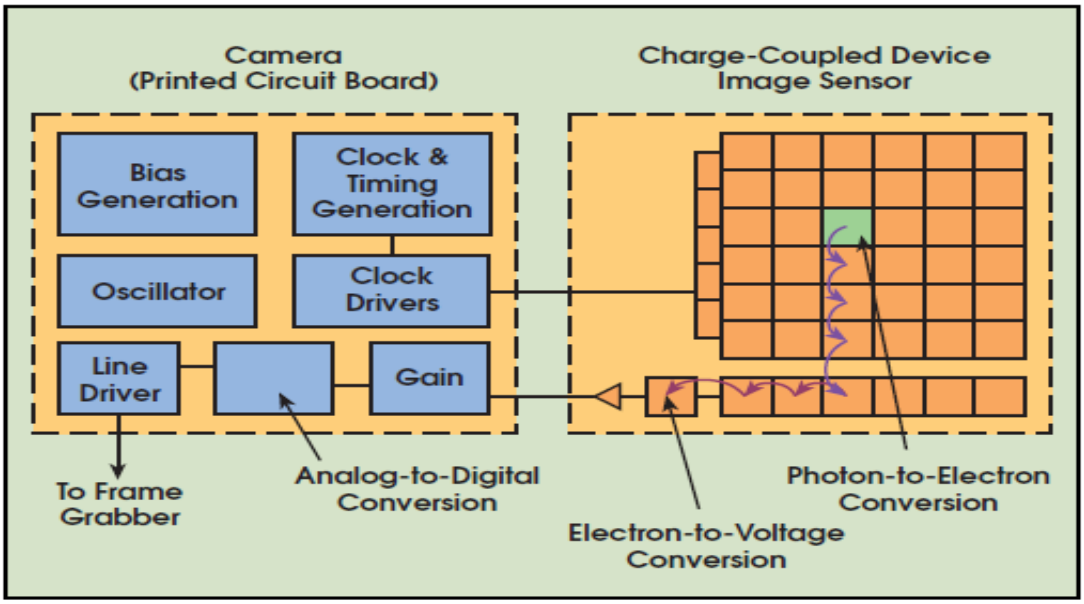

Figure 2.1: CCD system structure overview[12]