UNIVERSITY TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF AUTOMATIC QUALITY CONTROL SYSTEM USING VISION SYSTEM

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics and Automation) with honours

by

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I hereby, declared this report entitled "Development of Automatic Quality Control System Using Vision System" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics and Automation) with honours. The member of the supervisor committee is as follow:

…….

Supervisor

ABSTRAK

Mesin sistem visi banyak digunakan dalam industri untuk tujuan pemeriksaan. Sistem menyusun automatik dan sistem pemeriksaan visi yang dilaksanakan untuk integrasi telah membina sistem automasi. Kecekapan ia memeriksa dan menyusun secara teratur telah member banyak faedah untuk mengatasi kelemahan sistem konvensional yang dijalankan oleh pekerja. Integrasi konveyor ke sistem yang dicadangkan adalah untuk menghantarkan objek untuk diperiksa. Kemudian, sistem pemeriksaan dimulakan dari pengesanan sensor fotoelektrik untuk mengaktifkan "webcam" menangkap gambar melalui satu PLC. Gambar yang ditangkap akan didigitalkan oleh "webcam" dan menghantar ke hos komputer untuk pemprosesan gambar dengan menggunakan perisian Vision Builder Automated Inspection (VBAI). Konfigurasi untuk perisian VBAI akan dipelajarikan sebelum pemeriksaan visi dijalankan. Sementara itu, grafik antara muka pengguna direkakan dengan menggunakan perisian Labview tujuan untuk pengguna mengawasi and mengawalkan sistem tersebut. Objek yang diperiksa akan disusun secara teratur oleh robot. Ia adalah satu robot enam paksi yang mempunyai ruang kerja yang berbentuk separuh-bola. Namun, integrasi elektronik seperti papan "relay" adalah diperlukan untuk menyelesaikan masalah ketidaksamaan voltan antara PLC dan prosesor Rhino. Sebagai kesimpulan, projek ini telah dijalankan untuk mengklasifikasikan objek dengan menggunakan pemeriksaan secara visual dan eksperimental validasi ke atas prestasi sebenarnya.

ABSTRACT

Machine vision systems are widely used in manufacturing industries for inspection purpose. The implementation of automated sorting system to machine vision system has develops an integration of automation system. Its efficiency to inspect parts and sort according to order offers advantages which against the limitation of conventional human-operated system. The integration of a conveyor to the proposed system feeds the inspected parts for inspection purposes. Then, the inspection system is started from a detection of photoelectric sensor to trigger USB webcam by image acquisition via a Programmable Logic Controller (PLC). The webcam digitized the image data in order to send to host computer for image processing by using Vision Builder Automated Inspection (VBAI) software. The configuration of VBAI is studied on a personal computer before vision inspection is carried out. On the other hand, a graphical user interface (GUI) is designed by using Labview for person-in-charge to monitor and control the entire system. After classification from VBAI software, the inspected parts are arranged accordingly by Rhino robot. It is a six axis robot arm which consists of a hemisphere of work space. Though, integration of electronic hardware such as relay boards are necessary to solve the different voltage signal between PLC and Rhino controller. As a result, this project is performed to classify parts by using developed visual-based inspection and experimental validated its actual performance.

ACKNOWLEDGEMENT

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Beyond the professional involved in this report, my coursemate and family were also quite influential in this work. Thanks to my coursemate for sharing their precious opinion, experience, comments and resources. Thank you for being there to listen to my gripe about my work. Thanks for my beloved family unending support and motivation.

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DEDICATION

I dedicate this report to my beloved parents, without their patience, support understanding and most of all loves, the completion of work would have not been possible.

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LIST OF ABBREVIATIONS

ADC	-	Analogue-to-Digital Converter
APS	-	Active Pixels
CAPS	-	Complementary Active Pixels Sensors
CCD	-	Charged-Couple Device
CCTV	-	Close Circuit Television
CID	-	Charge-Injection Devices
CMOS	-	Complementary Metal-Oxide Semiconductor
DOF	-	Degree of Freedom
GUI	-	Graphical User Interface
I/O	-	Input/Output
LED	-	Light Emitter Diode
OLE	-	Object Linking and Embedding
OPC	-	OLE for Process Control
PC	-	Personal Computer
PCB	-	Printed Circuit Board
PIC	-	Person-in-charge
PLC	-	Programmable Logic Controller
PMOS	-	P-type metal-oxide-semiconductor
PPP	-	Prismatic, Prismatic, Prismatic
PPS	-	Passive Pixels
PVC	-	Polyvinyl Chloride
RGB	-	Red, Green, Blue
RPP	-	Rotary, Prismatic, Prismatic
ROI	-	Region of Interest
RRP	-	Rotary, Rotary, Prismatic
RRR	-	Rotary, Rotary, Rotary
USB	-	Universal Serial Bus
VBAI	-	Vision Builder Automated Inspection
VDC	-	Voltage Direct Current
VLSI	-	Very-large-scale integration

2-D - Two dimensions

3-D - Three dimensions

CHAPTER 1
INTRODUCTION

1.1 Background

The essential goals in the implementation of automation system in the industries are to provide improvement in human operator variances and operational efficiency. It is known in that many cases, product quality consistency can vary depending on the characteristic of human operators who are on duty. Hence, automation system should be provided to improve this variance. The problem associated with human-assisted operation is characterized by cycle time, repeatability and material handling. Although operational efficiency has been given a top priority, human operators are still exposed to high probability of injuries, long-term similar working scope in fast motion, applications naked eyes inspection-based system and insufficient break time.

In order to improve operational efficiency and to improve safety of human operators, there is a need for efficient, high repeatability and cost effective human-assisted operation equipment. Mechanized and automized solution that are properly sized with suitable modularized structure can greatly improve the safety of personnel as well as efficiency and quality of production. In addition, such efficient automation system with high repeatability can greatly improve the operational efficiency, product quality and product consistency when applied in combination with intelligent instrumentation and advanced control.

The mechanized and automized operation system include robot arm, programmed conveyor system, inspection system and host computer are necessitated to implement in industries purposely to increase operational efficiency and product quality. A 6 degree of freedom (D.O.F) of robot arm which possess wide working area has

enlarge the approaching region and various orientation. Therefore, it is a wise solution to be used to substitute the folklore operation system like human operator in industries by robot arm. Besides, the evolution of conveyor from manual operate to automated conveyor system has enhanced the product handling and increase the cycle time as well. The implementation of vision system for inspection in production line becomes a booster for inspection compare to old-fashion naked eye inspection. The mechanized and automized systems are integrated with intelligent vision system enable the whole production processes execute in fully automatic. Thus, the operational efficiency is increase effectively and greatly decreases the variances of product quality.

1.2 Problem Statement

Nowadays, human-operator based industries require longer time to inspect using naked eye and sort the products into the correct slot or container. This action of inspection and sorting consume more time and results in the operators unable to meet the cycle time. Low repeatability is one the effects of long working time on similar, repeating working scope at fast motion. Therefore, the operators may get tired and bored resulting in bad inspection and sorting quality of the products. Due to the limitations, an automated inspection system based on a vision system integrated into a pick-and-place robot is required.

1.3 Objectives

Based on the problem statements stated above, several objectives are to be obtained at the end of this project. The objectives of this project are:

i. To design visual-based inspection system
ii. To classify and sort products using vision inspection system

1.4 Scope

This project will focus on vision-based inspection and products sorting. The scopes of this project are:

i. Image acquisition using a webcam.
ii. Configure vision inspection algorithm based on Vision Builder Automated Inspection (VBAI).
iii. Validate vision inspection system by interfacing a pick-and-place robot, a webcam, a personal computer, a programmable logic controller (PLC), and a conveyor.
iv. Classify product in term of different colours and shapes.

The fabrication of conveyor, robot arm and development of software will not be covered in this project.

1.5 Expected Result

This project is expected to improve the inspection process in terms of colour sorting and shape orientation for packaging purpose. The product will be conveyed and inspected for its colour and differentiated in term of shape using image processing technique. A robot then removes the product and places it in a correct slot at right orientation.

1.6 Content

This report is presented in several chapters that describe the development of automatic quality control system using vision system. Chapter 2 discusses the Literature Review that describes about the related information from journals and books. Chapter 3 describes the Methodology of the proposed work and shows a flow chart of process that explains the operational process supported with some statement.

Chapter 4 explains the Experimental Setup and Procedures of the installation and integration of vision-based inspection system and sorting system. Chapter 5 illustrates on Results and Discussion about the results obtained from experiment. The important findings will be presented in a comprehensive manner. A comparison between the desired result and the actual result are performed in order to identify any limitations to the system that is being proposed. In addition, the projected objectives will be reviewed to ensure that goals met. Furthermore, suitable recommendation for further improvement to the system will be included. Chapter 6 will conclude the entire project with summarize the main findings and review the scopes covered.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter discusses the literature review related to the proposed vision-based inspection system. Review of previously developed systems in literature review are discussed and illustrated. This chapter discusses mainly the vision system, sorting system, conveyor and sensors that are relevant to the development of the proposed system.

2.2 Vision System

Vision system can be described as image acquisition, followed by image processing and interpretation. The processed image data is transferred by computer for some other useful application. Vision system is classified into two dimensional (2-D) and three dimensional (3-D). 2-D is most suitable for industrial applications that include dimension measurement, gauging, check for the presence of components and etc. (Groover, 2000). Vision systems are widely used in inspection section in industry. The implementation of vision system increase the efficiency and accuracy of inspection process because the high repeatability and accuracy of machine has overcome the disadvantages of human-based operation system. Thus, sales of 2-D vision system outnumber those of 3-D systems by more than ten to one. Figure 2.1 shows the basic functions of machine vision system.

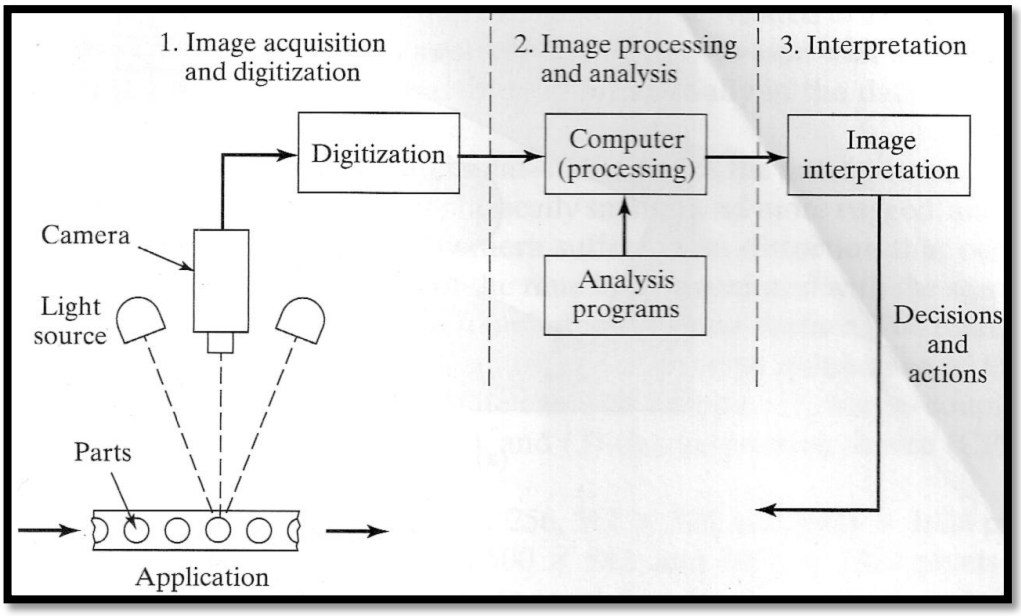

Figure 2.1: Basic functions of machine vision system (Groover, 2000).

Image data acquisition is accomplished using a video camera where the image data is transferred to digitizing system to store the data for further analysis. The camera is focused on the region of interest (ROI), and an image data is obtained by dividing the viewing area into a matrix pixel, arranged in pixel arrays. The intensity value of a pixel is converted by analog-to-digital converter (ADC) to equivalent digital value which is proportional to the light intensity. An image is represented in continuous with respect to the x- and y- coordinates and in amplitude as well. In order to convert it to digital form, an image is needed to digitizing the coordinate value (sampling) and digitizing the amplitude value (quantization). In practice, the arrangement of sensor used will determines the method of sampling to generate the image (Gonzalez and Woods, 2002). The result of sampling and quantization of an image function, $f(x, y)$ now become discrete quantities resulting in a digital image with M rows and N columns based on the matrix shown in equation 2.1. The coordinate convention of pixels that represent digital images is shown in figure 2.2.