UNIVERSITI TEKNIKAL MALAYSIA MELAKA

VISION INSPECTION SYSTEM FOR PRODUCT DEFECT

Thesis submitted in a accordance with the requirements of the
Universiti Teknikal Malaysia Melaka for the Degree of
Bachelor of Manufacturing Engineering (Robotics & Automation) with Honours

By

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APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic and Automation) with Honours. The members of the supervisory committee are as follow:

……..

Supervisor

DECLARATION

I hereby, declare this thesis entitled "Vision Inspection System for Product Defect" is the results of my own research except as cited in the reference.

Signature : …….

Author's Name : ……

Date : ……

ABSTRACT

Vision system is one of the most advance systems in industrial automation to replace conventional method of inspection done by human operator. Visual inspection requires high-speed, high-magnification, 24-hour operation, and repeatability of measurements. All of these tasks extend roles traditionally occupied by human beings, whose degree of failure is classically high through distraction, illness and circumstance.The use of vision to enhance the operation of an automated work cell has moved from research laboratory to the factory floor. In order to design the vision inspection system, lots of aspect should be taken into consideration. This includes tools used, the environment, the materials and most important things are the purpose of the inspection. The pharmaceutical industry relies heavily on automated process-control and quality-assurance systems to ensure that batch production is carried out repeatable, reliably, and accurately. Thus vision inspection system for pharmaceutical industry requires critical consideration in develop automated inspection system. This project focuses on the development of vision inspection system to detect product defect for pharmaceutical product.

ABSTRAK

Sistem penglihatan adalah salah satu sistem maju dalam automasi industri untuk mengantikan pemeriksaan cara lama yang di lakukan oleh operator manusia. Pemeriksaan mengunakan penglihatan memerlukan kelajuan, ketelitian, berkerja 24 jam dan pengukuran berulang-ulang. Kerja-kerja ini melebihi tahap kerja yang di lakukan oleh manusia, yang mempunyai kecuaian yang tinggi kalau di ganggu, sakit dan sebagainya. Pengunaan sistem penglihatan untuk memperbaiki operasi sel kerja automatik yang sebelum ini hanya di gunakan dalam makmal perlu dipindahkan untuk digunakan dalam kilang. Untuk mereka sistem pemerikasaan menggunakan penglihatan, banyak aspek yang perlu di ambil kira. Ini termasuk penggunaaan alatan, keadaan sekeliling, bahan yang digunakan dan yang paling penting tujuan pemeriksaan. Industri perubatan bergantung pada proses kawalan automatik dan sistem kepastiaan kualiti untuk memastikan produksi berjalan lancar. Oleh sebab itu sistem pemeriksaan mengunakan penglihatan untuk industri perubatan memerlukan pertimbangan yang kritikal dalam menghasilkan sistem pemeriksaan automatik. Projek ini memberi fokus kepada penghasilan sistem pemeriksaan menggunakan penglihatan untuk mengesan kerosakan pada produk perubatan.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

ADC	-	Analog to Digital Converter
AI	-	Automated Inspection
BGA	-	Ball Grid Array
CCD	-	Couple Charged Device
CMOS	-	Complementary Metal Oxide Semiconductor
CRT	-	Cathode Ray Tube
DOF	-	Depth of Field
DPI	-	Dots per Inch
FDA	-	Food and Drug Administration
FOV	-	Field of View
GMPs	-	Good Manufacturing Practices
GUI	-	Graphic User Interface
HMI	-	Human Machine Interface
I/O	-	Input / Output
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
MMX	-	Matrix Math Extensions
MTF	-	Modulation Transfer Function
MV	-	Machine Vision
NG	-	Not Good
OK	-	Okay
PC	-	Personal Computer
PCI	-	Peripheral Component Interconnect
PPI	-	Pixel per Inch
RGB	-	Red Green Blue
USB	-	Universal Serial Bus
VGA	-	Video Graphic Accelerator

CHAPTER 1
INTRODUCTION

1.1 Backgrounds

The use of vision to enhance the operation of an automated work cell has moved from research laboratory to the factory floor. Vision systems can be programmed to perform narrowly defined tasks such as counting objects on a conveyor, reading serial numbers, and searching for surface defects. Vision systems are being used increasingly with robot automation to perform the following task:

- Part identification: Commercially available vision system store data for different parts in active memory and use the data to distinguish between parts as they enter the work cell.
- Part location: Vision technology allows the user to locate randomly placed parts on an X-Y grid. The vision system measures the X and Y distances from center of the camera coordinate system to the center of the randomly placed part.
- Part orientation: Every part must be gripped in a specified manner by the end of arm tooling. The vision system supplies the orientation information and data that are used to drive the gripper into the correct orientation for part pickup
- Part inspection: Vision systems are used to check parts for dimensional accuracy and geometrical integrity.
- Range Findings: In some applications the system uses two or more cameras to measure the X, Y, Z location of the part.

Manufacturers usually used vision systems for visual inspections. Visual inspection systems are used to check parts for dimensional accuracy and geometrical integrity. These parts are measured by camera and the dimensions are calculated by the image processing program; at the same time, the vision system checks the parts for any missing holes or changes in the part geometry (Asfahl, 1992). Data collect from the vision system will be analyzed and the defect of the product can be categorized. Refer Figure 1.1 for the communication of vision inspection system.

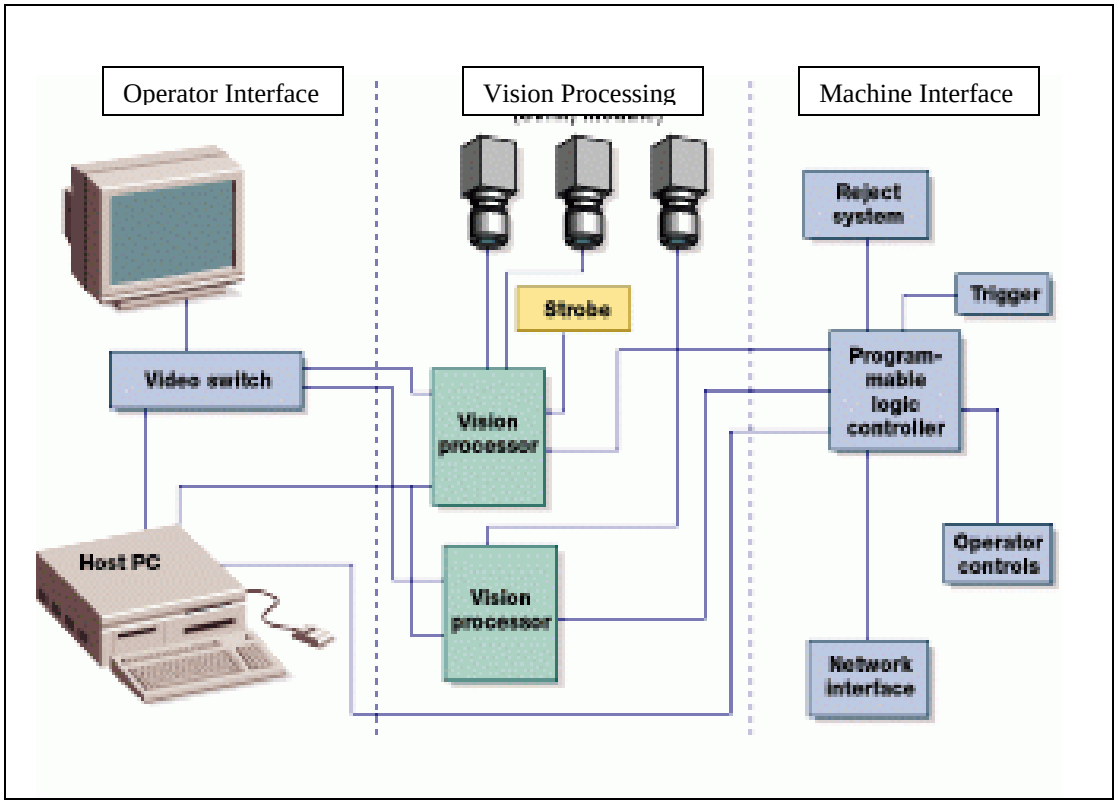

Figure 1.1: Vision Inspection System Design (Hardin, 2000)

An inspection is, most generally, an organized examination or formal evaluation exercise. It involves the measurements, tests, and gauges applied to certain characteristics in regards to an object or activity. The results are usually compared to specified requirements and standards for determining whether the item or activity is in line with these targets.

1.2 Project Overview

This project will be focusing on inspections system using the vision sensor. The product to demonstrate the inspection system is a medical glass bottle container that used to fill the cough syrup. The product was chosen due to the high quality inspection prefer for this kind of product. Using the available programming software to programming the inspections system, this project will result in the suitable program for inspections defect on the medical glass bottle container.

1.3 Problem Statement

In manufacturing process, there will always be a defect in the product. Even though this defect is only 1% from the batch, it is still a defect. For instance, when the product that needs to be exported has slightly 1% of defect, the manufacturing company is putting their profits in line where a great loss to the company can happen due to this 1% of defect. Worst, the company has to bear other consequences such as lost of clients and even being sued for negligence. Therefore this defect should not reach the user, as the last end product should be 100% perfect. Where, the defect can be solved using the visual inspection, ultra wave inspection and other type of inspection.

This project has chosen the medical containers as the product. This is because the pharmaceutical industry relies heavily on automated process-control and quality-assurance systems to ensure that batch production is carried out repeatable, reliably, and accurately. Moreover, there is probably no other industry where proper quality assurance and quality control can literally make the difference between cure and casualty (Haystead, 1997).

Visual inspection requires high-speed, high-magnification, 24-hour operation, and repeatability of measurements. All of these tasks extend roles traditionally occupied by human beings, whose degree of failure is classically high through distraction, illness and circumstance. Although humans may display finer perception over the short period and greater flexibility in classification and adaptation to new defects and quality assurance policies, but they make error and can not be hoped 100% perfect with their job (Asfahl, 1992).

The eyes inspection can be reliable for short period of time but in making the system automated, non-stop inspections system and high reliability result are needed in the system. It is impossible for the operators to inspect the product for 8 hours or at least 2 hours straight without making any flaws in its inspections.

1.4 Objectives

In order to develop a successful project, objectives should be achieved. The objectives are required to assist and guide the development of the project. The objectives for this project are to:

- categorize the defect (defect by vision system, defect by product) and store the defect data in a database
- design and develop a system to automatically inspect a product defect

1.5 Scopes

a) Vision System

- The system are use only for inspection of the medical container – STREPSILS cough syrup bottle only
- The inspection will detect defect of that bottle only

b) Camera

- The camera is choosen based on the application and economical expense.
- The chosen camera will be use only to acquire picture to be process by the image processing software.

c) Product

- The product selected to be use for the project is only one type, which is empty medical glass container – STREPSILS cough syrup bottle
- This vision inspection system will be only focusing defect of the bottle on that type of product only.

d) Programming Image Processing Software

- Image processing software selected is use to process the image and compare with the original image.
- The program for the inspection is program only to inspect the defect of the product only.

CHAPTER II

LITERATURE REVIEW

2.1 Vision System

Vision can be describe as ability to see the features of objects that look at, such as color, shape, size, details, depth, and contrast. Vision is achieved when the eyes and brain work together to form pictures of the world around. Vision begins with light rays bouncing off the surface of objects. These reflected light rays enter the eye and are transformed into electrical signals. Millions of signals per second leave the eye via the optic nerve and travel to the visual area of the brain. Brain cells then decode the signals into images, providing sight to the human (Microsoft ® Encarta ® 2006).

In industry sector, vision is use with machine to automate the system. It consists of establishments that supply technology used in manufacturing industries as a substitute for the human vision function. It is made up of suppliers of systems that embody techniques leading to decisions based on the equivalent functionality of vision, but without operator intervention.

The characteristic of these techniques include non-contact sensing of electromagnetic radiation, direct or indirect operation of an image, the use of a computer to process the sensor data and analyze that data to reach a decision with regard to the scene being examined, and an understanding that the ultimate function of the system performance is control (process control, quality control, machine control or robot control) (Zuech, 2000).

Machine vision system can be characterized as newly approach field and diverse. The machine system is now being used in many fields such as medical, industrial quality control, military, astronomy field and other fields. Figure 2.1 shows the field of vision system.

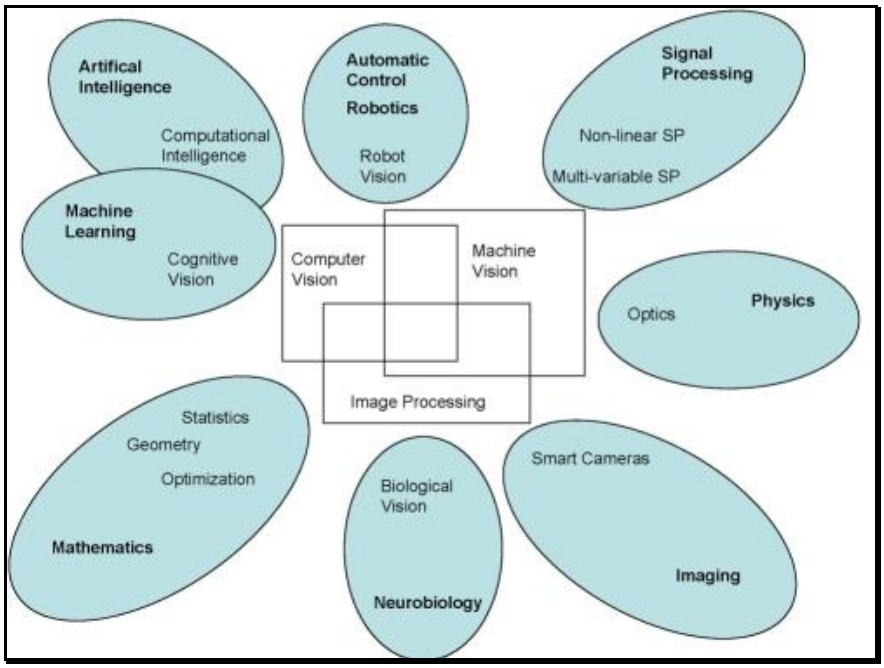

Figure 2.1: Vision System Field (Zuech, 2000)

Machine vision is distinct from computer vision. Computer vision extends to topics related to autonomous robotics and machine representation of human vision. Machine vision refers to automated imaging systems including a wide range of computing disciplines aggregated to form a complete solution to visual problems and can be considered a superset composed of computer vision and elements such as equipment control, data basing, network systems, interfacing and machine learning (Zuech, 2000).

2.1.1. Human Vision vs Machine Vision

Living creature eye can be defined as light-sensitive organ of vision in humans (Microsoft ® Encarta ® 2006). The eyes of various species vary from simple structures that are capable only of differentiating between light and dark to complex organs, such as those of humans and other mammals, which can distinguish minute variations of shape, color, brightness, and distance. The actual process of seeing is performed by the brain rather than by the eye. The function of the eye is to translate the electromagnetic vibrations of light into patterns of nerve impulses that are transmitted to the brain (Microsoft ® Encarta ® 2006).

The eye is nearly sphere, with an average diameter of approximately 20mm. Three membranes enclose the eye: the cornea and sclera outer cover, the choroids, and the retina. The cornea is a tough, transparent tissue that covers the anterior surface of the eye. Continuous with the cornea, the sclera is an opaque membrane that encloses the remainder of the optic globe. Refer Figure 2.2 for the structure of human eye.

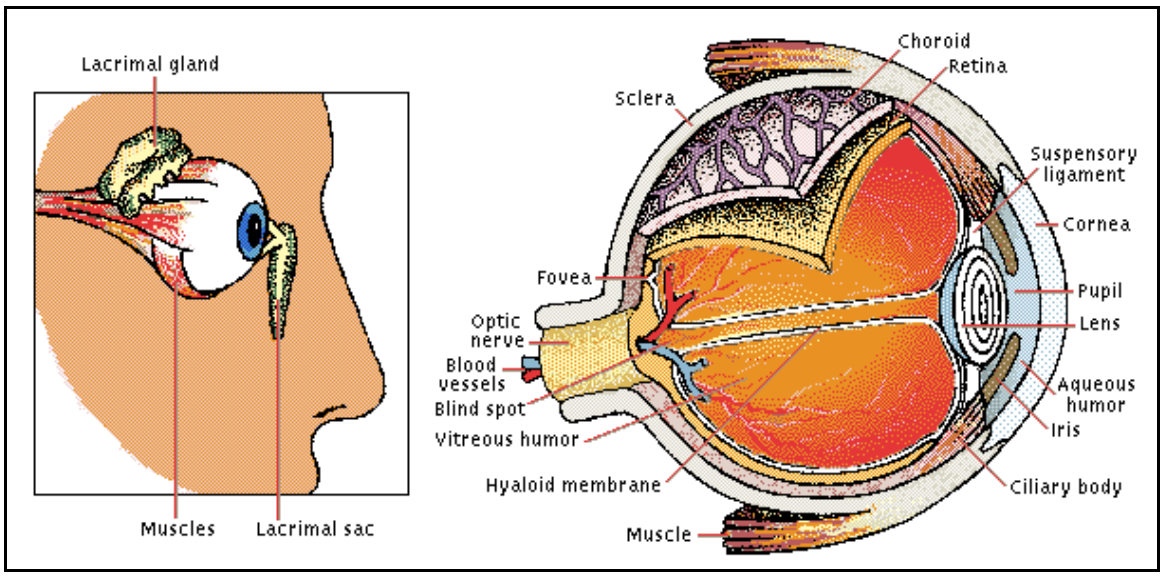

Figure 2.2: Structure of Human Eye (Encarta Encyclopedia, 2006)

The innermost membrane of the eye is the retina, which lines the inside of the wall's entire posterior portion. When the eye is properly focused, light from an object outside the eye is imaged on the retina. Pattern vision is afforded by the distribution of discrete light receptors over the surface of the retina. They are two classes of receptors: cones and rods. The cones in each eye number between 6 and 7 million. They are located primarily in the central portion of the retina, called the fovea, and highly sensitive to color.

The fovea itself is a circular indentation in the retina of about 1.5mm in diameter. Fovea can be view as a square sensor array of size 1.5mm x 1.5mm. The density of cones in that area of the retina is approximately 150,000 elements per mm^2. Based on these approximately, the number of cones highest acuity in the eye is about 337,000 elements. Just in terms of raw resolving power, a couple-charged-device (CCD) imaging chip of medium resolution can have this value of elements in a receptor array no larger than 5mm x 5mm (Gonzalez, 1992).

Machine vision has been defined by the Machine Vision Association of the Society of Manufacturing Engineers and the Automated Imaging Association as the use of devices for optical, non contact sensing to automatically receive and interpret an image of a real scene in order to obtain information and/or control machines or process. It uses a lens to capture a picture of the object and focus it onto a sensor plane. The quality of the lens will influence the quality of the images. Distortions and aberrations could affect the size of features in image space. Vignette in a lens can affect the distribution of light across the image plane. Magnification of the lens has to be appropriate for the application. As much as possible the image of the object should fill the image plane of the sensor. The imaging sensor that use in the machine vision system will basically dictate the limit of discrimination of detail that will be experienced with system (Zuech, 2000).