DEVELOPMENT OF VISION INSPECTION SYSTEM FOR AUTOMOTIVE ASSEMBLED PART

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

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

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SESI PENGAJIAN: **2012/13 Semester 2**

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I hereby, declared this report" Development Vision Inspection System for Automotive Assembled Part" 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) (Hons.). The member of the supervisory committee is as follow:

(Co-supervisor)

DEDICATION

This work is dedicated to my beloved late father, who always inspired me to be competent and work hard in every works that I have done. Special dedicated to my mother whose love and pray accompanies throughout my life. It is also dedicated to my fiancé, who always supporting and motivating me along the accomplishment of this project.

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ABSTRAK

Pembangunan Sistem Pemeriksaan Visual merupakan projek kerjasama antara UTeM dan PHN Industri Sdn.Bhd. Projek ini dijalankan khusus untuk menghasilkan algoritma menggunakan untuk system visual menggunakan perisian MATLAB dan kemudiannya algoritma ini diuji prestasinya melalui beberapa ujian. Dua algoritma telah dibangunkan bagi sistem visual ini iaitu; Perhubungan Korelasi (*Coefficient Correlation, CC)* dan Penjumlahan Kaedah Kuasa Dua menggunakan Perhubungan Silang (Summing Square Difference using Cross Relation,SSDXCORR). Kedua-dua algoritma ini diuji dengan menggunakan sampel-sampel yang mempunyai pelbagai kecerahan, putaran dan kecerahan. Kedua-dua algoritma ini juga diuji masa pemproessan imejnya dan ketepatan semasa diuji dengan sampel yang diubah secara rawak. Hasil ujian menunjukkan CC mempunyai prestasi yang lebih baik dari SSDXCORR bagi ujian kecerahan yang berlainan dan ketepatan. Manakala, SSDXCORR mempunyai prestasi yang lebih baik dalam ujian orientasi dan kelajuan masa pemprosesan imej.

ABSTRACT

The Development of Vision Inspection System for Automotive Assembled Part is a project between UTeM and PHN Industry Sdn. Bhd. The main purposes of this project are to develop algorithms for vision inspection system using MATLAB and to verify the performance of vision inspection system that has been developed. Two algorithms; Coefficient Correlation (CC) and Summing Square Method using Cross Relation (SSDXCORR) have been developed and tested. Both algorithms performance have been tested by subjecting samples with different rotations and brightness. Both algorithms performance has also being verified by observing image processing time and accuracy while subjecting randomly modified images samples. Through the experimental result of this study, it is concludes that CC has better performance than SSDXCORR in term of higher accuracy and higher percentage of detection under different brightness and SSDXCORR has better performance in term of faster image processing time and higher percentage detection while subjecting variant image orientation. In a nutshell, this study has achieved its objectives.

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CC	-	Coefficient Correlation
CR	-	Cross Relation
CCD	-	Charged-couple device
CDI	-	Cloudy Day Illuminator
CMOS	-	Complementary Metal Oxide Semiconductor
DOAL	-	Diffuse On Axis Light
EDR	-	Enhance Data Rate
FKP	-	Fakulti Kejuruteraan Pembuatan
SCDI	-	Square Continuous Diffuse Illumation
SSD	-	Sum Squared Different
MATLAB	-	MATrix LABoratory
PAN	-	Personal Area Network
PC	-	Personal Computer
PHN	-	Proton-Honda-Nagoya
ROI	-	Region of Interest
SSDXCORR	-	Cross Correlation based Sum of Squared Difference
UTeM_	-	Universiti Teknikal Malaysia Melaka
Wi-Fi	-	Wireless fidelity
W/O	-	Without

CHAPTER 1
INTRODUCTION

The development of Vision Inspection System for Automotive Assembled Part is a university-industry collaboration (UIC) project between PHN Industry Sdn. Bhd and UTeM. In this project, a vision inspection system for assembled automotive part has been developed. This project focused on image processing, developing algorithm and programming for vision system using MATLAB. Sample for this research is a car door. This system inspected the assembled metal part by firstly capturing the image, processing the image and comparing the image with template images data before executing result; whether current part is accepted or rejected.

1.1 Project Background

1.1.1 Vision Inspection System

Vision system is generally known as automatic extraction of information from images. This system consists of lens, lighting, sensors, and vision processing and communication unit. They commonly used in various fields, medical, traffic controlling and industry, normally for checking and inspection purpose. Counting, measurement, location and decoding are examples of familiar application of this system. Figure 1.1 showed an example of vision system layout.

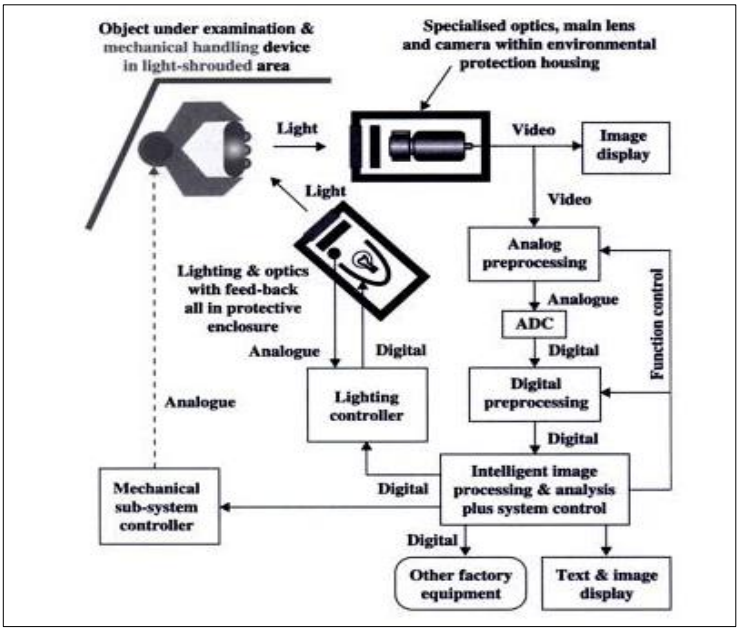

Figure 1.1: Archetypal machine vision system.
(Graves & Batchelor, 2003).

1.1.2 Advantages using vision inspection system

Automated inspection stage by using vision system has many advantages; reduce pass through defects, increase yield and can track and trace where defects occurred.

In real industry world, precision and quality of the products are very important. Everything must lies within tolerances and comply their requirements. Issues regarding pass through defected products to the market, which finally need to be recall back is definitely brings bad reputation to company itself. Besides, company has to burden cost incurred; cost to call back products and other penalty cost. Therefore, vision systems as inspection system can lead to fewer catastrophes go to customer hand; therefore reduce the cost incurred and maintain good reputation of company. Example of mislabelled food product is shown in Figure 1.2 below:

Figure 1.2 : Exampled of mislabelled product (Microscan System Inc., 2012).

On top of that, vision inspection system also enabled company to have better yield; ability to turn input product to saleable end product. The soon the defects are eliminated , especially from entering next stage, the more the material can be saved from being scrap or need to rework. Moreover, vision inspection system may also keep the defected and good products record after being inspected. Company may have as many records as they want relevant to their storage memory. Therefore, if any defected products miss into next stage or line, it still can be track and trace based on storage memory.

Machine vision also has many advantages as compared to human inspectors. This can be explained through comparison in Table 1.1 below:

Table 1.1: Comparison vision system and human.

Aspects	**Vision system**	**Human**
Work duration	Vision system work tirelessly even for a long time.	Human will get tired and need rest after certain time work.
Quality of work	Can work consistently and repetitively. They can work all day for the same work with minimum error. They follow all parameters setting as before.	Human inspector is inconsistent and easily tired with repetitive work. They may lost concentration and error may increase as time being.
Rate of work	Faster than human.	Slower than machine system.

1.1.3 Applications of Vision Inspection System

According to (Graves & Batchelor, 2003)and Steger, Ulrich and Wiederman (2008) vision system provided imaging-based automatic inspection and analysis for applications such as automatic inspection, process control, and robot guidance in industry. Vision system is increasingly used with robot automation to perform various task; part identification, inspection, location, orientation, and range finding (A.Rehg, 2000).

Part identification is an example of vision system application that has been commercialized now. The image that has been captured is stored in memory and later will be used as data to distinguish part as they enter the work cell. From this storage data, system learns the characteristic of different parts and identifies each part from its two-dimensional silhouette. This feature can stand-alone, act as sorting purpose or air with inspection ability, where system recognise object and count the number of object. For example, in beverages packaging, the system will recognise the bottle and inspect whether the number of bottles inside a box is correct (refer to Figure 1.3).

Figure 1.3: Counting application of vision system, (Microscan System Inc., 2012).

Part inspection also can be done by using vision system. Inspection term here is used for dimensional checking; diameter of the part (Figure 1.4) and geometrical integrity; number of holes (Figure 1.5). Parts are measured by camera and the dimensions are calculated.

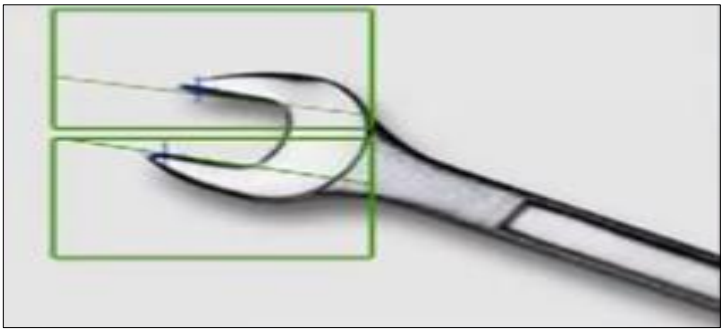

Figure 1.4: Vision system inspect spanar dimension.
(Microscan System Inc., 2012).

Figure 1.5: Number of holes is counted by using vision system

(Microscan System Inc., 2012).

Vision system also allow user to locate randomly placed parts on X-Y grid in. It measures X and Y distances from the centre part of camera coordinate system to the centre of the randomly placed part(Figure 1.6). This method also can be used to know part orientation by applying certain extra mathematical formulas.

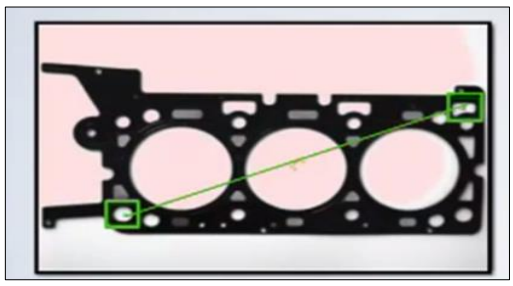

Figure 1.6: Locating the position and knowing orientation of part is some of the application in vision system (Microscan System Inc., 2012).

In the meanwhile, range finding is used to measure and calculate cross-sectional of parts. Other than above application, vision system also able to decode. This can be done by capturing and processing the bar code (Figure 1.7).

Figure 1.7: Decoding application by using vision system (Microscan System Inc, 2012).

Note that, beside integrated with robot, machine vision also can be integrated with PLC or stand-alone too (A.Rehg, 2000).

1.1.4 UIC Collaboration

Development Vision Inspection System for Automotive Assembled Part is university-industry collaboration (UIC) project between PHN Industry Sdn. Bhd. University-Industry Collaboration (UIC) is a strategic cooperation which provided win-win results between university and industry.

In UIC, industrial provides data and field of research and university share the latest knowledge. Moreover UIC is a golden opportunity for scholar to research and proposed solution for industrial problems. For industry, it is a great opportunity to explore new high-tech solution with low investment and risk.

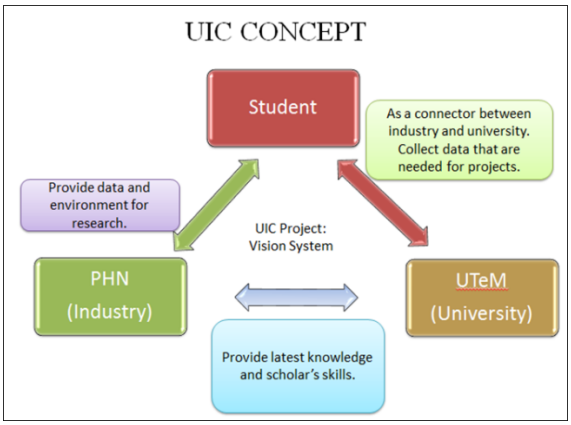

Figure 1.8: UIC Concept.

The collaboration between UTeM and PHN opens numerous opportunities. The development of the system benefits the UTeM in term of knowledge gain, industry exposure, professional acknowledgement (i.e. IR/PE) and portfolio proliferation. Meanwhile, PHN gains advantages in good return of investment (ROI) by producing higher number of quality products yet less investment cost.

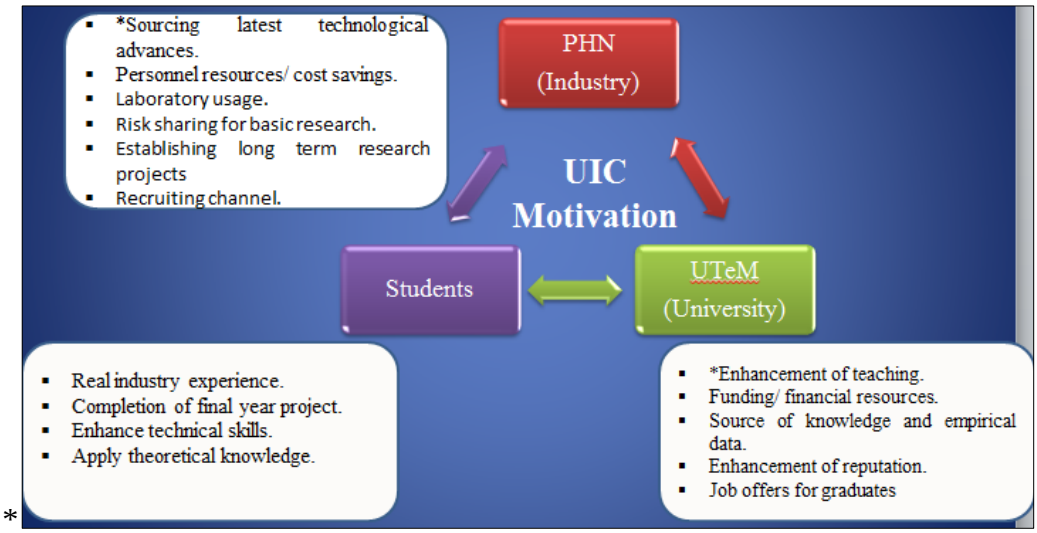

Figure 1.9: University-Industry Motivation.

1.1.5 Company Profile

PHN Industry Sdn. Bhd., abbreviated from Proton-Hicom-Nagoya is a Malaysian automotive manufacturer components founded in 1990. PHN is headquartered in Shah Alam, Selangor, Malaysia. It also owns four other plants in BB, USJ, Pekan and Melaka. It is a part of DRB Hicom group.

There are three main activities; stamping, assembly and die manufacturing. Stamping is normally done by using dies that are provided by customer to shape the sheet metal. For assembly, normally, the part that has been welded has been stamped in the PHN itself or from outsourcing. Meanwhile, in die manufacturing, PHN manufacture dies to be used internally and imported to external market.

Figure 1.10: Main PHN Industry Customers.

1.2 Problem statement

PHN Industry Sdn. Bhd is well-known as one of established suppliers for car manufacturers in Malaysia; Proton, Perodua, Toyota and Honda. With mission **“** To provide our customers with superior quality product at a competitive price”, PHN Industry always give the best to ensure their supplied components always comply customers’ requirement. However, in real world, there are many obstacles they have to handle.