UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DETECTION OF DEFECT OF AN AUTOMOTIVE PART USING IMAGE PROCESSING APPROACH

This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Tajuk: **DETECTION OF DEFECT OF AN AUTOMOTIVE PART USING IMAGE PROCESSING APPROACH**

Sesi Pengajian: **2021/2022 Semester 1**

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DECLARATION

I hereby, declared this report entitled "Detection of Defect of An Automotive Part Using Image Processing Approach" is the result of my own research except for the data received from the company and as cited in references.

Signature : .....

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Date : 12 January 2022

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

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ABSTRAK

Di sektor pembuatan, jabatan kawalan kualiti memainkan peranan penting untuk memastikan produk yang dihasilkan adalah berkualiti tinggi. Salah satu elemen penting dalam kawalan kualiti adalah pemeriksaan. Namun, ketika berurusan dengan pemeriksaan, ada beberapa masalah yang timbul seperti tidak dapat mengesan kecacatan, kekurangan ketepatan dan ketidakcekapan untuk mengenal pasti kecatatan. Menggunakan pemeriksaan manual dan peralatan yang salah membawa kepada masalah besar kerana ia akan memakan masa pemprosesan yang lebih lama. Di samping itu, masalah ini juga mendorong kadar pertumbuhan aduan pelanggan. Oleh itu, ada keperluan untuk mencadangkan penyelesaian menggunakan pendekatan pemprosesan gambar berkaitan dengan pemeriksaan untuk menyelesaikan masalah ini. Projek ini bertujuan untuk mencapai tiga objektif iaitu mengenal pasti kekerapan bahagian acuan suntikan yang dihasilkan, merancang algoritma melalui teknik pemprosesan imej untuk mengesan bahagian yang rosak dan menganalisis keberkesanan teknik pemprosesan gambar untuk pemeriksaan kualiti dari segi ketepatan dan masa pemprosesan. Terdapat lima bahagian yang disertakan untuk menjalankan projek ini mengikut prosedur iaitu pengecaman frekuensi kecacatan, pemilihan kaedah untuk pemprosesan gambar, pengembangan pengkodan MATLAB, debugging pengkodan MATLAB, dan menganalisis pemeriksaan automatik. Perisian MATLAB Simulink akan digunakan untuk menghasilkan algoritma dan Antaramuka Pengguna Grafik (GUI) dalam projek ini. Sebanyak 100 sampel telah diperiksa dan ketepatan yang diicapai ialah sebanyak 96% dengan 8.81 saat masa pemeriksaan yang dapat dikurangkan. Persekitaran pemeriksaan harus dikawal dengan mengawal pengcahayaan untuk meningkatkan kualiti pemeriksaan. Akhir sekali, keupayaan sistem ini boleh dinaiktaraf untuk mengesan kecacatan 3D supaya sistem menjadi lebih baik dan berguna untuk syarikat.

ABSTRACT

In manufacturing sector, quality control department plays a significant role to ensure the product produced are high quality. One of the important elements in quality control is inspection. However, when dealing with inspection, there are several issues that arise such as being unable to detect defect, lack of accuracy and inefficiency to identify defect. Using manual inspection and incorrect equipment leads to major problems due to lack of accuracy which will consume longer processing time. Besides, this issue also encourages the growth rate of customer complaints. Owing to this reason, there is a need to propose a solution using image processing approach with regards to inspection to solve this problem. This project is aimed to achieve three objectives which are to identify the frequency of defective injection moulded part produced, to formulate an algorithm via image processing technique to detect defective part and to analyse the effectiveness of image processing technique for quality inspection in term of accuracy and processing time. There are five parts included to conduct this project according to the procedure which are defect frequency identification, method selection for image processing, development of MATLAB coding, debugging MATLAB coding, and automatic inspection analysis. MATLAB Simulink software is used to generate the algorithm and Graphical User Interface (GUI) in this project. A total of 100 parts sample was inspected and the accuracy achieved is 96% with 8.81 seconds of processing time reduced. The inspection environment must be controlled by controlling the illumination to improve the inspection quality. Finally, the ability of this system may be upgraded to detect 3D defects so that the system will perform better and more useful for the company.

DEDICATION

For my parents Azman Bin Wahid and Zushahidah Binti Mohd Said,

who always gives endless support and motivation,

My supervisor Ir. Dr. Lokman Bin Abdullah,

who have encouraged, guided and inspired me throughout the process,

And myself.

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TABLE OF CONTENTS

CHAPTER 3: METHODOLOGY

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

ABS	-	Acrylonitrile Butadiene Styrene
ADF	-	Anisotropic Diffusion Filter
AQL	-	Acceptance Quality Level
CAR	-	Customer Claim and Action Report
CAT	-	Computer Axial Tomography
CMOS	-	Complementary Metal Oxide Semiconductor
FYP1	-	Final Year Project 1
FYP2	-	Final Year Project 2
GUI	-	Graphical User Interface
HE	-	Histogram Equalization
HIS	-	Hue, Saturation, and Intensity
IPQC	-	In-Process Quality Control
IPT	-	Image Processing Tool
ISO	-	International Organization for Standardization
K1	-	KEYTOP 1
K2	-	KEYTOP 2
LED	-	Light Emitting Diode
NG	-	No Go
OK	-	Okay
PDCA	-	Plan-Do-Check-Act
QC	-	Quality Control
QM	-	Quality Management
QP	-	Quality Procedure
RGB	-	Red Green Blue
RoHS	-	Restriction of Hazardous Substance
SDD	-	Surface Defect Detection

UCD	-	User-Centred Design
UD	-	Unique Diamond Sdn. Bhd.
UL	-	Underwriters Laboratories
USB	-	Universal Serial Bus
UTeM	-	Universiti Teknikal Malaysia Melaka
2D	-	2 Dimension
3D	-	3 Dimension

LIST OF SYMBOLS

s	-	Second
Sqm	-	Square meter
%	-	Percent
×	-	Multiply
Kg/m^3	-	Kilogram per meter cube
MYR/kg	-	Malaysian Ringgit per kilogram
GPa	-	Giga Pascal
MPa	-	Mega Pascal
HV	-	Vickers Hardness
$MPa.m^{0.5}$	-	Mega Pascal meter
°C	-	Degree Celsius
W/m. °C	-	Watt per meter degree Celsius
J/kg. °C	-	Joule per kilogram degree Celsius
μ	-	Micro meter
Ω	-	Omega
V/m	-	Volt per meter
MJ/kg	-	Mega Joule per kilogram
Kg/kg	-	Kilogram per kilogram

CHAPTER 1
INTRODUCTION

1.1 Background of Study

This report is aimed to discuss on creating a new inspection method approach for a plastic injection moulding company. Plastic injection moulding has become one of the most important and widely used polymer processing operations nowadays in the plastic industry. Unique Diamond Sdn. Bhd (UD) is first incorporated on 26th of August 1992 and is located at Taman Sentosa, Klang, Selangor, Malaysia. Other than its main process which is injection moulding, this company also provides other 3 secondary processes which are spray painting, pad printing and sub-assembly. The factory area is approximately 7000 sqm and has 2 buildings which are Block A for office and industrial area and Block B for warehouse. The company shareholders are 100% Malaysian and also has an approved UL Code which is H1131. Manufacturing license number for this company is B10-G6-2010-00000014-A and has gained two ISO namely; ISO9001:2015 Quality Management and ISO14000:2015 Environment Management. The company has incorporated the RoHS procedures into ISO9001 and ISO14000 in April 2009.

Most of the moulded polymer are made for automotive parts, accessories, power meter or flow meter, professional camcorder and also vacuum metalizing part with various and complex design of the plastic components which have triggered the concern regarding its cost and easiness. This process would also produce defective part due to wrong selection of machine parameters and also from a poorly maintained mould. These problems are able to be solved by developing model optimisation that correlates with their responses and process parameters, although optimising its parameter needs an endeavour (Hentati and Masmoudi, 2020). The study is about detecting defects that are invisible to the naked eyes without any help of instrument such as dented, scratches, black dot, drag, and sink

mark and at the same time to propose the best solution for inspector to perform quality control inspection method by using advanced technologies. Image processing is a technique that is introduced to the company as one of the effective inspection methods that convert image into a digital form that needs to perform some operations to receive an enhanced image or extract useful information from it.

In industrial inspection, In-Process Quality Control (IPQC) where it is implemented in QP-019 under ISO9001:2015, is a crucial task for inspector as they are dealing with the accuracy and specification of the raw part directly from production. The process flow of this quality process is attached in appendix A for further reference. Based on the observation received from industrial training with a duration of 10 weeks long from 20th July 2020 to 25th September 2020, the company is required to have both soft copy and hard copy documents. Sorting and rework must be performed and filled in the rework sheet when there is a detection of defective part before delivery. Presence of leakage in defective part that has reached to customer, a Customer Claim and Action Report (CAR) will be sent to the company for a complaint. Pictures with defect highlight are attached with CAR and QC needs to fill up the action taken, why it happens and how to prevent it from happening again as requested in the CAR. The defect that occurs on the part eventually creates problem in term of the production subsequent processes and also the customer. The main purpose of Surface Defect Detection (SDD) is to avoid the defective parts containing defects on the surface and prevent it from reaching out to customer (Han and Shi, 2007).

Surface defects need to be converted into pixels that can be differed from its original image pixels (Chisti, Srinivas and Prasad, 2015). Each quality problem requires different techniques of inspection for its precise evaluation. For image processing, reflectivity and colour are the appearances absolute measurements and several numbers can be given as its value. Local defect considers the surface area with a view that does not match the actual surface quality which makes the image parameters relative values more important. It is necessary to conduct large figure of parameters measurements and at the same time analyse the change in parameters over the examined area while detecting the local defect (Chisti, Srinivas and Prasad, 2015).

1.2 Problem Statement

In current situation, Unique Diamond Sdn. Bhd (UD) is using manual inspection most of the time and Smart Scope to perform IPQC for 4 samples every 4 hours during the production of the automotive part sampling. Based on 10 weeks observation from 20th July 2020 to 25th September 2020, defect overlook among the IPQC inspectors frequently happened due to ineffective method. Surface Defect Detection (SDD) by manual control has its own disadvantages and quality control provides important feedback loop that creates potential impact in manufacturing business. Due to the part micro-defects on the surface and overlook by IPQC inspector, the raw part has passed QC check for outgoing to be delivered to customer upon request. There will be an on-hold part or production issued which will interrupt the production and delivery planning. Due to having on-hold issue, it will indirectly reduce the manufacturing productivity. Over the year 2020, the customer has requested at least eight times for 100% checking for the delivered lot that contains defect with a result of 1.80% scratches, 0.34% dented, and 0.12% black dot using manual inspection. This will require the company to withdraw some money for transportation and also employment cost. Owing to this reason, it has caught the top management's attention and there is a need to use different approach to cater for this problem.

1.3 Objectives

The objectives of this project are as follows:

a) To identify the frequency of defective injection moulded part produced.

b) To formulate an algorithm via image processing technique to detect defective part.

c) To analyse the effectiveness of image processing technique for quality inspection in term of accuracy and processing time.

1.4 Scopes of Research

The scopes of this research are as follows:

a) This research was carried out at the In Process Quality Control (IPQC) Area in Quality Control Department of the plastic injection moulding industry.

b) The study is limited to inspection on the part's surface only.

c) The software used for defect detection is MATLAB Simulink.

1.5 Significants of Study

a) There are some potential benefits that can be gained by the company after the completion of this study when the company adopts the idea proposed since it is able to solve their problem that relates with their customer.

b) The output of this research project is expected to reduce the processing time during inspection process.

c) The efficiency and accuracy of detecting defect will increase in term of percentage.

1.6 Organization of Report

a) Chapter 1: Introduction

This chapter is the introduction of the study where it begins with the research background that discusses about the study of this research and also the company background. Problems are identified through verbal communication with industrial supervisor and observation during internship is stated in the problem statement. Objectives, scope of research and

significants of study are delineated in order to define the particular aspects of research on using the image processing approach for detecting defective automation part. The impact of this study is shared to the company.

b) Chapter 2: Literature Review

This chapter covers the basic theories regarding the research topic and the previous studies from journals, articles, books and the search engine. It explains about the study deeply with the aid of the previous data and journals which focus critically on the project related studies.

c) Chapter 3: Methodology

The methodology describes about the preparation required and also describes the method selected to be performed for this project. Each process from analysing data to detecting defect is explained in detail for clearer information.

d) Chapter 4: Algorithm & GUI Design

This chapter emphasize the formulation of the algorithm to create an inspection method using image processing using image processing toolbox and app designer features in MATLAB. The process of converting image is shown step by step in this chapter. Besides, the graphical user interface (GUI) is designed based on the end user preference.

e) Chapter 5: Results & Discussion

This chapter analyses the information collected after performing testing through the image processing operation and data received by the software for the results recording. Then, the effectiveness of using image processing approach is discussed according to the result received.