UNIVERSITI TEKNIKAL MALAYSIA MELAKA

VISION INSPECTION SYSTEM FOR SORTING APPLICATION

Submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

by

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APPROVAL

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

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ABSTRAK

Pengurusan sisa terbuang adalah salah satu cabaran yang dihadapi masyarakat masa kini. Strategi utama yang dilaksanakan oleh kebanyakan negara termasuk Malaysia dalam menangani isu ini adalah dengan kitar semula. Namun di Malaysia, proses pengasingan barang-barang kitar semula di pusat-pusat kitar semula adalah dilakukan oleh pekerja-pekerja di situ. Pelbagai masalah timbul apabila tenaga manusia digunakan antaranya keletihan, isu kebersihan, dan lambakan barang-barang kitar semula kerana proses pengasingan tidak dapat dibuat dengan pantas. Berbanding dengan negara-negara maju, proses ini mendapat bantuan daripada teknologi terkini. Oleh itu, projek ini mengetengahkan satu kaedah untuk mengenal pasti sisa terbuang dengan bantuan manusia yang minima untuk meningkatkan produktiviti, keberkesanan, dan mengurangkan masa yang diperlukan untuk mengasingkan barang. Projek ini menggunakan system penglihatan mesin untuk mengenal pasti 3 bahan bungkusan minuman yang biasa terdapat di Malaysia. Bahan ini dikenal pasti melalui bentuk bungkusan minuman tersebut dengan menggunakan teknik-teknik pemprosesan imej seperti penyaringan imej, morfologi, pengisian banjir, pengesanan tepi, dan pengesanan kontur. Dengan teknik-teknik ini, luas kontur, nilai sentroid, dan perimeter untuk pelbagai jenis paket minuman dapat ditentukan. Parameter inilah yang digunakan dalam mengklasifikasikan jenis bahan yang berbeza dari pembungkusan minuman mengikut ukuran yang berbeza. Luas kontur bagi botol plasik merupakan 237656.0 pixels, nilai sentroid adalah Cx= 1032, Cy=510 dan perimeter adalah 6385.718812823296 pxels. Bagi bottle kotak susu, luas kontur adalah 491889.0 pixels, sentroid koordinate adalah Cx=1061, Cy=546 dan perimeter adalah 5035.7568155527115 pixels. The luas kontur, nilai sentroid dan perimeter untuk tin aluminium ialah 229176.0 pixels, Cx=1139, Cy=549 dan 5040.961124300957 pixels.

ABSTRACT

Nowadays, waste management challenges have been one of the major issues that people have been facing. Recycling is one of the strategies that most governments around the globe, including Malaysia, tend to prioritize and adopt to deal with this problem. In Malaysia, human beings make most of the difference from waste to be recovered. Nonetheless, several problems arise due to hygienic exhaustion, increased labor expenses and overloading of waste due to poor improvement in the physical separation of waste. When it comes to waste management or recycling in overseas countries, most waste systems require state-of-the-art technology. An idea is therefore developed for applying waste management approaches using technologies to maximize profitability, performance and reduce the time required to identify the waste. Utilization of a vision inspection system to separate different types of waste packed for beverages on different materials of different sizes to demonstrate solutions for waste separation. The waste spectrum is limited to three forms of drink packaging waste normally produced in Malaysia. In order to distinguish drink packaging through vision inspection, a series of image-processing algorithms is created. Techniques of image processing, like image filtering, morphology, flood filling, edge detection and contour detection are used to differentiate the form of drink packaging. In the meantime, different contour area, centroid value and perimeters for various types of drinking package, which demonstrate that the vision inspection system can be used in classifying the different material type from drinking packaging according to different sizes. The contour area for plastic bottle is 237656.0 pixels, centroid coordinate is at Cx=1032, Cy=510 and the perimeter is 6385.718812823296 pixels. For paper carton bottle, the area 491889.0 pixels, centroid is Cx=1061, Cy=546 dan perimeter is 5035.7568155527115 pixels. The area, centroid value and perimeter for aluminum can is 229176.0 pixels, Cx=1139, Cy=549 and 5040.961124300957 pixels.

DEDICATION

Only

My beloved father, Low Ou Tick

My appreciated mother, Chong Sin Tai

My adored sister, Low Shee Ling

for giving me money, encouragement, supports and understandings

Thank You So Much & Love you All Forever

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LIST ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

%	-	percentage
σ_i^2	-	variance
"	-	inch
cm	-	centimeter
kg	-	kilogram
Lm	-	Lumen
ml	-	milliliter
t	-	ton
2D	-	Two Dimensional
3D	-	Three-Dimensional
CCD	-	Charged Coupled Device
CCIR	-	Commander's Critical Information Requirement
CMOS	-	Complementary Metal–oxide–semiconductor
EIA	-	Electronic Industries Association
FGPA	-	Field-programmable Gate Array
GIS	-	Geographic Information System
GPS	-	Global Positioning System
HD	-	High Definition

HMM	-	Hidden Markov Model
LA	-	Local Authorities
LabVIEW	-	Laboratory Virtual Instrumentation Engineering Workbench
LED	-	Light-Emitting Diode
LoRaWan	-	Long Range Wide Area Network
MATLAB	-	Matrix Laboratory
NET	-	Microsoft Web Services Strategy
NGO	-	Non-governmental Organizations
NTSC	-	National Television Standards Committee
OOP	-	Object-Oriented Programming
OpenCV	-	Open Source Computer Vision Library
PAL	-	Phase Alternate Line
PCA	-	Principal Component Analysis
PET/PETE	-	Polyethylene Terephthalate
RFID	-	Radio-frequency Identification
ROI	-	Region of Interest
SMEs	-	Small and Medium-sized Enterprises
USB	-	Universal Serial Bus
VCS	-	Visual Cryptography Scheme

CHAPTER 1

INTRODUCTION

1.1 Background of Study

There is problem regarding to handling the waste every day. In order to solve the problems of overloading of waste, recycle method can be used to reduce the amount of waste. However, in Malaysia, recycle of waste is normally done by human manually (Chiam and Joshua, 2018). A lot of problems occurring when manually handling the waste to be recycle, looking at the method of handling the waste in overseas country, it can be known that the implementation of method of handling the waste using technology will increase the productivity, effectiveness and decrease the time consuming(Hussein and Mansour, 2018). In this project, Machine vision (MV) is used as the inspection system in this project to replace the human vision that normally use to differentiate various types of waste that can be recycle. Machine vision has come from an era with a deep theoretical base in a proven, valued field of research and implementation. The vision of a machine specifically concerns the study and implementation of systems which allow machines to recognize objects from image data acquired and to carry out useful tasks (Myler, 1998). Despite the lack of modern technologies, 2D and 3D vision systems for automatic inspection, robot guidance, quality control and sorting are now widely used and much more. These smart inspection systems include a camera or several cameras, like recording and lighting. Vision systems may calculate components, inspection of components in the right position and the form of the components understand. Vision systems are also capable of

measuring and arranging high speed pieces. Computer software uses photos collected during the process to analyze data collection. (Davies, 2005). The vision system can be intelligent enough to make decisions that impact which type of waste of the drink packaging can be recycle and differentiate the waste according to its material. After that, by using the machine such as robot arm, it can be program to sort the different type of materials of waste into different places according to its categories, Vision systems can assist robotic systems in obtaining the positioning of parts for further automating sorting and streamlining for further recycling or any manufacturing process. This idea is developed from the internship project in National Formosa University.

1.2 Problem Statement

The recent years have seen many exciting developments in the field of recycling. Recycle is an important action that reduce the amount of landfill waste, conserves the natural resources and protect the ecosystem. In daily life, a lot of waste will be producing especially when consuming different type of drinks, there are many types of drinks packages made from different materials that can be recycle such as glass, paper, tin and plastic bottles. In order to separate the waste from other general waste, normally human will manually differentiate these waste and sort it in different categories for recycle uses. Nonetheless, manually separated waste is faced with a number of issues, such as the longer time needed due to human eyes, increased labor costs, abundance of waste and hygiene issues when handling various categories of waste material for recycling (Saffron *et al.*, 2003).

1.3 Objectives

The objectives of the project are important in order to ensure that the research is carried out in order to solve the problem that has been investigated. All the objectives are shown as below:

i. To develop a low-cost vision inspection system for sorting application.

ii. To classify the different shape of material of type of drink packaging using vision inspection system for recycle purpose.

1.4 Scope

The scope of this project will be fixed according to the requirements from the objectives. By referring to the first objective, this project focused on to sort different types of drink packaging which consumed in human's daily life. However, there are too many types of drink packaging currently available in the market. Therefore, for this project the scope is limited to only four types of drink packaging that consist of different type of material which can be recycle. Furthermore, this project focused on choosing the low cost of choice of components that need to be utilize in machine vision because the objective of this project is to develop a low-cost vision inspection system for sorting application.

i. Aluminum can

ii. Plastic bottle

iii. Paper carton bottle

Figure 1.1: The scopes of different types of drink packaging.

1.5 Importance of Study

The manner in which the waste is treated is very critical since the rise in the waste population will have many consequences for people (Smith *et al.*, 2001). Therefore, it is really important to implement recycling method to reduces the amount of waste and at the same time protect the environment. The environmental conditions in developing countries are badly affected by the damping of solid waste. The adverse environmental impact of excessive disposal of solid waste can easily be found in all developing countries (Naveed *et al.*, 2010).Recycling is the safest way of treating the waste in compare to the traditional techniques such as combustion of waste polymers or underground burying that have negative environmental impacts through the production of smoke, fumes and toxic gases (Bratu *et al.*, 2013).Therefore, recycle of waste is the waste handling method that must be implement as it protect the environment from harmful substances that can cause negative environment impacts.

In this project, vision inspection system is used to differentiate the different type of drink packaging waste. Machine vision technology is a method that should be implement in most of the application. Machine vision technology has advanced on many levels, from the world of science fiction to the field of commercial practice. Such display systems make for more apps than ever a very appealing option. Whenever a fading process of recognition is needed, which requires high speed and precise, machine view is particularly suitable for improvement in a difficult mutation (Chen, 2016). No matter in any types of the application, the time consuming, productivity and the cost is the issue that always concerned. While using machine vision applications compare to the human vision applications, machine vision technology has help to achieve better goal for any sort of process such as sorting applications, defects detection application and many else. The productivity of machine vision is higher since the machine can work continuously for a long time; however human being will feel fatigue after working for a long period. Normally, the companies are very emphasizes on the productivity of their application or services, in order to save the cost for the company and earn a high profit, high productivity is essential for especially the sorting application of different types of products (Črešnar and Nedelko, 2017). The machine vision also contributes to reducing the employees '

labor costs to employ them in comparison to human vision, since the costs they use to purchase the machine can be high, but there will be no more costs in a long term. For this initiative, the specification in machine vision is about waste management. Therefore, the staff may need to hold near the waste full of germs, microbes, and this is dangerous to their body's safety if using manual vision to discern waste (Proshad *et al.*, 2018).

1.6 Organization of Report

Chapter 1 discusses about the background of this project regarding the title of this project. The problem statements are identified through various researches method and literature review from the books, internet, journals and the latest global issue of the world. After identifying the problem, several objectives have been figured out to solve the problems statements. The scope of this project is limited so that when carry out the experiment testing for this project, the data can collect and analysis in a proper way. The importance of applying the engineering background knowledge in a proper way when running this project also have been discussed in Chapter 1.

Chapter 2 have covered the basic theories, engineering knowledges and the details of information based on the title of this project. The information in this chapter is extracted from the literature review from books, journal, internets, magazines and many else. A lot of information has been collected from different sort of sources to gather and summarize all the information in this chapter.

Chapter 3 is basically about what is the method that are going to use to implement this project. After reviewing various information from the chapter 2, the knowledges have been gathered and come out with an idea to run this project. In this chapter, the way to implement vision inspection system for sorting application is planned and designed. The components needed in this project also have been compare from the information that gather in Chapter 2. This chapter will illustrate the experiment testing in this project that have to be carry out and