UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Automated Packaging Visual Inspector using Template Matching Algorithm in Image Processing

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

by

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910412-01-6360

FACULTY OF ENGINEERING TECHNOLOGY

2016

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Automated Packaging Visual Inspector Using Template Matching Algorithm in Image Processing**

SESI PENGAJIAN: **2016/17 Semester 2**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours. The member of the supervisory is as follow:

……

MR. SHAMSUL FAKHAR BIN ABD GANI

ABSTRAK

Isu yang melibatkan pembungkusan yang dihadapi oleh sektor pembuatan industri telah menjadi satu masalah yang besar. Isu ini telah mempengaruhi hasil statistik untuk industri pengeluar dan menjejaskan hasil pemasaran. Oleh itu, kemajuan teknologi dipilih untuk mengatasi masalah ini. Tujuan projek ini adalah untuk membangunkan algoritma yang cekap dan cepat untuk memantau kualiti pembungkusan. Oleh itu, projek ini meningkatkan pemeriksaan kualiti untuk pembungkusan dengan melaksanakan Sistem Automatik Visual Inspektor bagi pembungkusan dengan Menggunakan Teknik Template Pemadanan Algoritma dalam Image Processing. Sistem ini mengurangkan kebarangkalian kesalahan berlaku seperti pembungkusan campuran (pembungkusan salah) untuk produk yang akan dikeluarkan dalam masa yang tertentu dalam barisan pengeluaran.

ABSTRACT

The issue involving incorrect packaging faced by manufacturing industry has become a huge problem. This issue has influenced the statistical yield for industries manufacturers and affects the marketing outcome. Thus, the advancement of technologies is chosen to overcome this problem. The aim of this project is to develop an efficient and adaptable algorithm to monitor the quality of packaging whether correct packaging or incorrect packaging. Thus, this project enhances the quality inspection for packaging by implementing an Automated Packaging Visual Inspector using Template Matching Algorithm in Image Processing. This system minimizes the probability of faults to occur such as mixed packaging (wrong packaging) for a product that will be released in a certain time in a production line

DEDICATIONS

This thesis is dedicated to:

My Parents,
My beloved family,
My Supervisors,
My Lecturers,
And all my friends,

Thank you for their encouragement and support

ACKNOWLEDGMENTS

I would like to express my appreciation to my supervisor, Mr. Shamsul Fakhar Bin Abd Gani for giving me the valuable chance to have my final year project under his supervision. I appreciate all the assistance, inspiration and helpful discussion throughout the project. Despite being extremely busy with his work and responsibilities, he still managed to guide me, apart from advising me to find the finest solutions to almost every challenge.

My gratefulness goes to my academic supervisor, Ir. Nik Azran Bin Ab. Hadi for his provision and continuous advice along my study in UTeM. I am also thankful to my course mates who have been helping and coach me all the way of my entire study in UTeM.

Most important, I wish to give my special appreciation to my family for the unceasing support and attention in my entire study. Their endless support has prolonged to me throughout these four years study and my life in general.

In short, gratitude to the help and contributions given from all parties that had helped me finish this final year project successfully. Last but not least, sense of gratitude to everyone whose directly or indirectly have lent their hand in this venture. Through this final year project, I got valuable knowledge and I hope I able to use my knowledge in the future.

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LIST OF ABBREVIATIONS

APVI	-	Automated Packaging Visual Inspector
TMA	-	Template Matching Algorithm
IP	-	Image Processing
LCD	-	Liquid Crystal Display
CV	-	Computer Vision
DIP	-	Digital Image Processing
SAD	-	Sum of Absolute Difference
NCC	-	Normalized Cross Correlation
MATLAB	-	Matrix Laboratory
LAPACK	-	Linear Algebra Package
BLAS	-	Basic Linear Algebra Subprogram
IPT	-	Image Processing Toolbox
IDE	-	Integrated Development Environment
BDP I	-	Bachelor Degree Project I
BDP II	-	Bachelor Degree Project II
SSP	-	Serial Port Protocol

CHAPTER 1

INTRODUCTION

1.0 Background

These days, computer vision and image processing have effectively comprehended the quality issue confronted by the modern segment. According to Weyrich et al. (2012), the human vision was stated as another necessity assistance from innovation for guaranteeing better yield. In this innovation period, a technologies framework was played a major part as it gives a colossal advantage to manufacturer contrasted with a manual inspection. This is on the grounds that the quality review is known as a strict association that will guarantee the nature of merchandise that will be discharged to market is a brilliant item that met the desire. In the case of Wang et al. (2012), among the measures expected to handle the issue of cheddar quality issue, a few examination has been led to recognize the primary driver of the issue. Through the observation, the fundamental issue was recognized. The issue is brought on by the packaging of the cheeses itself. Subsequently, the answer for control this issue was chosen. This issue is handled by building up a computerized review in light of machine vision. This arrangement gives the positive results toward the end of the testing. The quality of packaging was effectively controlled by machine vision. In addition, Priyadharsini & Devi (2014) found an assessment of veins in human eye permits prior identification of eye infections, for example, glaucoma and diabetic retinopathy. Computerized picture handling strategies assume an indispensable part in retinal vein location. Several image processing techniques and channels are practical to distinguish and separate the traits of retinal veins, for example, length ,width, pattern, and edges. Thus, different templates based coordinated channels, Threshold Methods, Segmentation strategies, and useful ways to deal with disengage the veins are clarified. Moreover, this project of APVI using TMA in IP is emphasized to distinguish between correct patterns or labels of packaging that

run in a production line from defective ones. This system is only interested in classifying the same label or pattern for each packaging that runs in certain specified time. The fact acknowledges that every manufacturer has their own marketing ideas for their packaging to attract their customer's attention. The new invention of any idea has to go through R&D process first before commercialization. Therefore, there will be many product releases with different types of packaging pattern or label. This will increase the probability of faults to occur such as mixed packaging (wrong packaging) for a product that will be released in a certain time. This system will be implemented at the end of the first level step for packaging. Thus, this project will prevent the wrong packaging label or pattern from passing through the line packaging and reaches the next level step for packaging process. The rejected packaging will be alerted by alarm and LCD will display the process status whether pass or rejected in order to monitor the output and minimize losses. This system will hopefully increase the output of production line without any losses (rejected product), enabling the production system to run smoothly and more efficiently.

1.1 Problem Statement

The idea for this project came out after observing an experience during working in a production line as a production coordinator at Mondelez International located in Johor Bahru. The conventional system that used for a quality checking gave the bad implications to production line and as well affected the manufacturers. Regarding Wang et al. (2012), CV and IP has created to observe the nature of cheese packaging. This execution has tackled the issue of packaging. This framework has transformed into an advantage to numerous viewpoint in the industrial sector. Problem statements stated:

1. The conventional system has a possibility of causing delays in reaching a target for finished goods in the production line when packaging are mixed up. This delay happens when finished goods contain mixed up packaging found by Quality checker. In order to complete the process of repacking,

other products need to be postponed until there are enough manpower's in a line.

2. Consume more time to undo the packaging (waste time). There are time-consuming for repacking process if the Quality checker found the rejected of finished goods. Manpower's need to undo the packaging from completed to started.
3. Huge losses will happen to the company (High labour payment). Manpower's need to work overtime and re-pack the packaging in order to reduce losses if there are rejected packaging. Due to this situation, there will be short of manpower to run another product in others lines and others shift manpower's also need to work overtime.

1.2 Objectives

The objectives of an APVI using TMA in IP are:

1. To study about IP that focuses on template matching techniques
2. To design an automatic system that can differentiate the correct and incorrect pattern/label for each packaging by using MATLAB and implement TMA.
3. To use Arduino to display a statistical yield data onto LCD screen and alert the detection of mismatch pattern by a buzzer.

1.3 Scope

The scope for an APVI using TMA in IP focused on faulty detections as stated in objectives which are:

1. To focus on exact pattern or label to be detected on packaging by using template matching technique.
2. To demonstrate the usage on small packaging sizes (estimation sizes±:8cm×11cm, thickness±2cm) only.
3. To display packaging status whether pass or rejected on LCD and alarmed the buzzer in ranging 100m when the pattern is rejected.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will review the idea used in this project based on the bases and material gathered from records, website or journal. Template matching algorithm is a selected technique to implement this project. MATLAB was chosen to be the platform for encoded a code. The benefit and drawback of other software will also be considered.

2.1 Study of Image Processing

According to Zhang (2013) in the mid-1920s, the newspaper industry was one of the principal utilization of Image processing. Harry G. Bartholomew and Maynard D. McFalane were the creators of Bartlane Cable Picture Transmission System. Pictures were implied for link exchange and reproduced at the less than desirable end on a broadcast printer. The submarine link was utilized to exchange pictures amongst London and New York and initially used to transmit a photo over the Atlantic in 1921. While in the mid to late 1920s, Bartlane framework was enhanced and created higher qualities pictures. The augmentation on a number of tones in replicated picture. In the 1960s, figuring innovation enhanced the work in computerized picture preparing and it started to be utilized as a part of medicinal applications in 1970s. In 1980s, the utilization of digital image processing has detonated and they are presently utilized for a wide range of task in a wide range of territories such as industrial review, medicinal and many more. Figure 2.1 demonstrates that the early computerized picture with the enhanced advanced at the late 1920s.

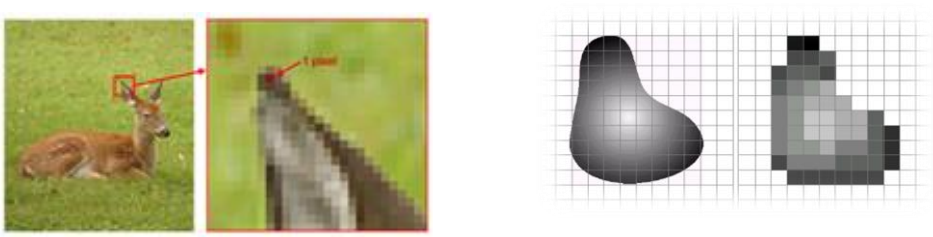
Figure 2. 1: Early digital image and improved digital image

(Zhang, 2013)

Figure 2. 2 : Early tone digital image

(Zhang, 2013)

Digital Image can be identified in two-dimensional pictures as a limited arrangement of computerized qualities $f(x, y)$. The strong point or gray level spoke to by the plentifulness of f at any pair of commands (x, y), while x and y are spatial (plane) organizes. A limited number of components which has a specific area and quality are made out of a computerized picture and alluded to as pixels. Digitization demonstrates that an advanced picture is an estimate of a genuine scene. Figure 2.3(a) and 2.3(b) demonstrates a digitization of a picture. The crates speak to the pixels of the picture, which is 1 box is equivalent to 1 pixel.



(a) (b)

Figure 2. 3 : Digitization of an image (a) RGB image (b) Grayscale image

(Zhang, 2013)

The common image formats include:

1. One tester per point (Black /White or Greyscale)
2. Three testers per point (RGB)
3. Four testers per point (RGB and Alpha/Opacity)

2.1.1 Fundamental Step in Digital Image Processing

Souza (2014) states there are some essential steps in IP. Figure 2.4 shows an essential steps in Arithmetical IP

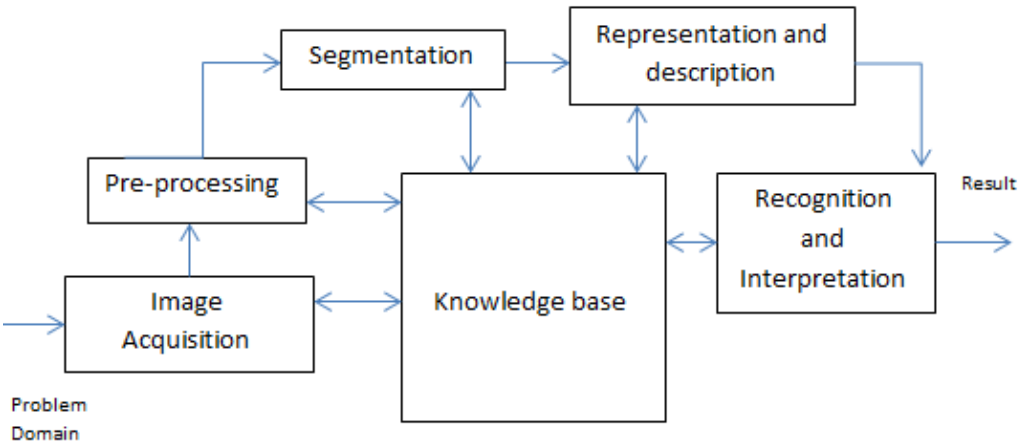


Figure 2. 4 : Essential steps in arithmetical image processing

(Souza, 2014)

These fundamental step are described as an image acquisition for acquiring an image from input(sensor). Firstly, image pre-processing will improve an image in a way (contrast enhancement, noise reducing, region isolating) that will increase the chance of other process to be success. Thus, image separation was used as an input image that will be divided into its suitable parts or objects and raw pixel data as a output. Image representation will works for the input sense to be converted into a suitable form for computer be able to process. The image description will extract a related features. Furthermore, image recognition will assigned an image with a label by its

descriptors based on information provided and lastly, image clarification is most important. An importance is relegated to an ensemble of a recognized objects.

2.1.2 Application of DIP

In the case of Gonzalez & Woods (2013), DIP has deployed in almost all field.

2.1.2.1 Application in Industrial Inspection

As was mentioned by Zhang (2013), digital image processing is beneficial applications in almost field. Other than medical application, there also application in Industrial inspection and much more. Obviously, digital image processing has extensively used in the industrialized field. Human operators are costly, moderate and untrustworthy. IP is effective on industrial inspection for defective detection, measuring, tracking, monitoring and much more. As for industrial inspection, DIP is used in order to make a machine do the task instead of manpower.

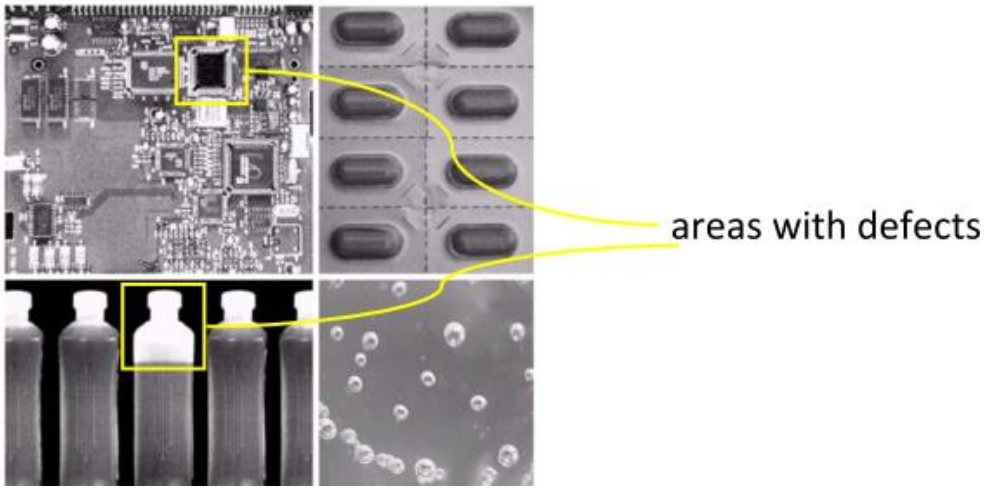


Figure 2. 5 : Examples of industrial inspection for defective products (Zhang,2013)

2.2 Study of Pattern Recognition

Tayebi et al. (2014) are concerned, pattern recognition is a categorization of input data into perceptible classes by taking out an important feature and unrelated details from a background. Based on the case study, this technique (pattern recognition) is useful for segmentation of vessel structures automatically. This technique was approached with 6 different approaches. Hence, it has brought about a positive result toward the end of the task.

According to Yu et al. (2012), impersonating human's visual abilities is dependably a test in machine vision. The hindrance emerges from the wide crevice of parallelizing handling speed between human's brain and the computer. Beyond the doubtful expense of building a computer for copying a mind, naturally, planning machine vision with compact calculations is a productive decision to adjust innate disadvantages of computers design. Tragically, even the essential picture handling like color segmentation and edge recognition normally credited to human's vision, separating an element by connecting up whole intrigue pixels into a conceivable example (shape) is an extreme occupation to computers.

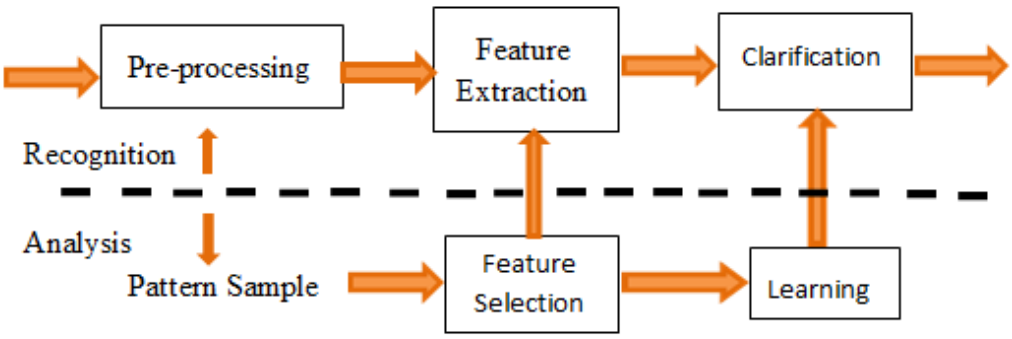


Figure 2. 6 : Pattern recognition model (Deep et al., 2014)

2.3 Study of Template Matching Technique

Johansson et al. (2015) claims that template matching is highly accurate technique used with the arrangement of down-sampling of board pictures to low pixel density. In arithmetical image processing, template matching is a illustrative

strategy for differentiating and recognizing an objects. The technique attempts to find a sub-picture (a reference) in a bigger pursuit picture by looking at the pixel values. Either a likeness or a disparity measure is figured for each point in the inquiry picture. Template matching does not rely on upon the item having an especially unmistakable component to have the capacity to distinguish it. This technique gave the huge beneficial in many aspects. The traceability system is successfully carried on using this technique.

According to Kumar et al. (2014), Template matching has turned out to be a capable innovation in the arena of Image processing for the diverse requests identified with remote detecting, medicinal, and other connected regions. A template based methodology gives a few application systems to identified arithmetical image processing handling ideas for a location of different components in the picture bits themself giving the necessary data from the particular picture segments. A combination of user uses the picture enlistments to gather records from the physical measures of the picture. A template matching in fundamental is similar the particular items of the basis picture utilizing a layout picture as appeared in figure 2.7. Common methodologies for complaint acknowledgment can be characterized into two general classifications; area based and feature based methodology. Area based approach sometimes called correlation sorts manage the pictures without endeavoring to distinguish striking objects window of favored size or the quest window is utilized for estimation of items while feature based techniques are central with respect to coordinating elements of the pictures utilizing contrast, color, hue, saturation and so on. Image registration has likewise been a vital point while the comparison of pictures or transient information study demonstrated the importance of image registration from various sensors and diverse perspectives with focuses in satellite pictures, matching stereo pictures and the fundamental innovation utilized as a part of the registration procedure couple of areas incorporated into the paper indicates feature based, search space, similarity metric, and so on regions secured in it are the medical control and computer vision. Comparative works are reflected additionally mirrored the change measures like Euclidian, similarity affine and so forth., with registration methods as pixel based, feature based, contour based, multi-modular and so forth. Template matching is the procedure of indenting any object in the primary picture better called as source picture with a template, small