AUTOMATIC COMPUTER VISION SYSTEM FOR INDUSTRIAL PRODUCT QUALITY INSPECTION

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PROJEK SARJANA MUDA II

Tajuk Projek : **AUTOMATIC COMPUTER VISION SYSTEM FOR INDUSTRIAL PRODUCT QUALITY INSPECTION**

Sesi Pengajian :

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Supervisor's Name : NORHASHIMAH BINTI MOHD SAAD

Date : .....

To my beloved father and mother

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ABSTRACT

Product quality inspection is the life business enterprises, only the objective, and strict inspection can promise the best quality of products left the factories. Therefore, the product quality inspection is a key job of business enterprises. Product quality inspection becomes a major issue in production and industrial. The problem is associated with a manual inspection that is done by a human. In facts, human as an inspector is slower and their efficiency is affected by their states of tiredness, illness or other human being shortcomings. This project presents an automatic computer vision system for industrial product quality inspection as a solution from the issue that has been raised. Soft drink is a product that is tested for quality inspection in this system. The offline system was designed to inspect the product based on color and water level classification using Visual Studio 2010 software. There are several image processing technique are used which are thresholding, morphological operation and segmentation. The system used Otsu' method for threshold the image and quadratic distance classifier to classify the color of the soft drink based on color classification. The water level will read the value of a white pixel that shows the height of the bottle. It is used to measure the range of water level. This system is also do in real-time testing that using conveyor, sensor and webcam. The experiment result shows that the system is 100% accurate for both offline and online system.

ABSTRAK

Pemeriksaan kualiti produk adalah hayat sesuatu perusahaan atau perniagaan dan hanya objektif yang berkaitan, dan pemeriksaan yang ketat boleh menjanjikan sesuatu produk berkualiti setelah keluar daripada sesebuah kilang. Oleh itu, pemeriksaan kualiti produk adalah tugas utama sesebuah perusahaan atau perniagaan. Pemeriksaan kualiti produk menjadi isu utama dalam pengeluaran sesebuah industri. Masalah ini berkaitan dengan pemeriksaan manual yang dilakukan oleh manusia. Fakta telah menunjukkan bahawa manusia sebagai pemeriksa adalah lebih perlahan dan kecekapan mereka dipengaruhi oleh keletihan, sakit atau lain-lain kelemahan. Projek ini membentangkan sistem penglihatan secara automatik oleh komputer untuk pemeriksaan kualiti produk industri sebagai penyelesaian daripada isu yang telah dibangkitkan. Minuman ringan adalah produk yang telah diuji untuk pemeriksaan kualiti dalam sistem ini. Sistem luar talian telah direka untuk memeriksa produk berdasarkan klasifikasi warna dan paras air yang menggunakan perisisan Visual Studio 2010. Terdapat beberapa teknik pemprosesan imej yang digunakan seperti pengambangan, operasi morfologi dan segmentasi. Sistem ini menggunakan kaedah Otsu ' untuk ambang imej dan pengelas jarak kuadratik untuk mengelaskan warna minuman ringan berdasarkan klasifikasi warna. Paras air akan membaca nilai piksel putih yang menunjukkan ketinggian botol. Ia digunakan untuk mengukur julat paras air. Sistem ini juga dilakukan dalam talian yang menggunakan penghantar, pengesan dan kamera web. Keputusan eksperimen menunjukkan bahawa sistem ini adalah 100% tepat untuk kedua-dua luar talian dan sistem dalam talian

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LIST OF ABBREVIATION

IKS	–	Industri Kecil Sederhana
RGB	–	Red, Green, and Blue
HSV	–	Hue, Saturation and Value
VB	–	Visual Basic
VS	–	Visual Studio
3D	–	3 Dimension
2D	–	2 Dimension
LED	–	Light Emitting Diode
ROI	–	Region of Interest
GUI	–	Graphical User Interface
IDE	–	Integrated Development Environment

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Product quality inspection is the life business enterprises, only the objective, and strict inspection can promise the best quality of products left the factories. Therefore, the product quality inspection is a key job of business enterprises. Visual inspection is a sub-item from machine vision that contributed so much modern manufacturing field. In the old days, this can be done with human inspection those using human eyes. In facts, human as an inspector is slower and their efficiency is affected by their states of tiredness, illness or other human being shortcomings [1]. In the modern days, visual inspection systems reduce human interaction with the inspected goods, classify generally faster than human beings and tend to be more consistent in their product classification. Visual inspection also has broad application in industrial automation and covers the full range of technical difficulty in computer vision [2].

The technique of automated visual inspection has an extensively applied foreground in the most modern automatic inspection of product quality [3]. This technique is based on computer vision is kind of method does not touch with inspecting

objects. This method uses integrated technology of image processing, exactitude measure, pattern recognition, artificial intelligence and so on. It is basic principle is to analyze the target images obtained by the computer vision system in order to get necessary measuring information, and judge whether the measured target is the norm or not according to the known knowledge. The image processing, process, and judges the collected images using the image processing and inspecting software and gets a conclusion whether the inspected object is in accord with the beforehand established request or not. Such inspection system extracts and analyzes a large number of features and automatically reject products that do not satisfy the set quality standards. As a result, automated visual inspection is undergoing substantial growth in manufacturing because of its cost effectiveness, consistency, superior speed, and accuracy.

The global beverage industry is growing constantly and the people are spending more and more money on it. The growing demand requires more efficient production. At the same time also demands on quality are increasing. Therefore, the manufacturers are forced to invest in faster machines and plants respectively. In the beverage industry, this has already started with the production of the preform and of a bottle and repeats itself, when the empty bottle is recycled and has become a new bottle.

Industri Kecil Sederhana (IKS) is defined as manufacturing companies that providing manufacturing related services with an annual turnover not exceeding RM25 million and employs a staff of full-time and does not exceed 150 people. Industri Kecil Sederhana (IKS) is also a manufacturing company that uses a small capital to produce their own product. This report will describe a software framework that used for this project and developing an automatic visual inspection system for inspecting the quality of beverage product.

1.2 Problem Statement

There exists no industrial vision system capable of handling all tasks in every application field. Global consumption of soft drink is increasing year by year. It is very

important to take care of the quality of the product delivered. To maintain the quality of such larger number of bottles is not an easy job. There are some IKS that still used manual inspection in their quality inspection process. With manual inspection, it is impossible maintaining the easy manufacturing flow. In the IKS, they are searching new ways to package and deliver their products to minimize their impact on the environment and reduce costs.

Based on the manual inspection and quality of product issues, this project is introducing an automatic computer vision system for industrial product quality inspection. It is because the vision applications have achieved a significant role in the packaging industry. It is also a much more efficient way of checking products and easier to be used. This project is proposed to overcome the problem of manual inspection by a human that is not efficient anymore and to reduce cost by industry. The quality control processes are based on color and level classification of soft drink bottle.

1.3 Objectives

There are several objectives that need to be achieved in this project. These objectives are:-

i. To implement image processing technique for the detection and classification of color and level of the beverage product.
ii. To develop the system based on classification method.
iii. To verify the performance of the system.

1.4 Scope of Work

This project mainly focuses on the software development that is designing an automated system to classify the soft drink bottle based on color segmentation and

level classification of each bottle. The hardware design is not involved in this project. The system will be designed using the Visual Studio software. The input image of soft drink bottle will be captured using a webcam. Then, the image will be analyzed, segmented and classified using the VS software. This system will be able to inspect of soft drink bottle based on color segmentation and level classification. This project is also focusing on five different flavors of soft drink, which are Strawberry, Grapes, Orange, Tropical and Root beer.

1.5 Research Methodology

This project only discusses on software development which is involving the algorithm development. The research methodology is an important part that shows the work procedure in order to complete the project. There are some research methodologies:-

- Data collection: An input image of soft drink bottle was taken by using a webcam as a sample image.
- Pre-processing: Color was analyzed by using RGB component, HSV component, and saturation component.
- Color segmentation: Color is segmented using the process of thresholding (Otsu' method), morphological operation and region of interest (ROI).
- Color classification: Quadratic Distance Classifier was used to calculate the threshold value between two sample images.
- Level classification: Each bottle has been set by a certain range of water level, which is passed, overfill and underfill.
- Performance verification: It shows the accuracy of the system.
- Field testing: Real-time testing.

1.6 Thesis organization

The report of this project is divided into five main chapters. There are Chapter 1: Introduction, Chapter 2: Literature Review, Chapter 3: Methodology, Chapter 4: Results and Discussion, Chapter 5: Conclusion and Recommendation.

Chapter 1 was explained about project background or project overview of the automated visual system inspection system. The problem statement of the project has been described and the reason for developing this project. The objectives are stated is related to the problem statement of this project. The scope of work is described the project requirement and research methodology is described what method used in this project. Thesis organization shows the report structure and organization.

Chapter 2 is an important part that needs to be understood by previous research was done that related to this project. This chapter will gather information about method and approaches that suitable to be used in this project from any resources. The previous research will be reviewed, discussed and summarized.

Chapter 3 will be discussed a method that used in this project. This chapter has explained the procedures that have been made in order to complete this project. The method used are RGB and HSV color model, Otsu' method and Quadratic Distance Classifier. All of this method will be applied in this project.

Chapter 4 is about finding the results and discussion of this project. This chapter was explained about the results of a simulation using VS software. The algorithm has been developed in the previous chapter and it will use to figure out the result in this chapter. The results will be discussed the acceptable or unacceptable of the beverage product, based on color segmentation and level classification.

Chapter 5 was described conclusion and recommendation in this project. An overall conclusion of this project has been discussed in this chapter. A specific recommendation has been recommended due to the issue that has been raised by the previous researchers.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In order to gain enough information to recommend the appropriate method that can be used to complete the research, comparison between certain techniques is required to detect and classify of color and level of the beverage product. This chapter explains and discussed related to the theory and basic principles, review of previous related work, and summary of this project. The research covered image acquisition, RGB color model, and level classification method.

The review of previous related works focuses on image processing technique for automatic product quality inspection that designed by respective researchers. The commercial value and market survey this project will also be discussed in this chapter so that the project will be beneficial to the market.

2.2 Theory and Basic Principles

The computerized method of image analysis is recently widely used in industry and is attracting a lot of attention and interest. It is caused by an increasing number of production requirements and development of computer technology [4]. Computer vision is a disciplined study how to reconstruct, interpret and understand a 3D scene from its 2D images in terms of the properties of the structures present in the scene. Besides, the ultimate goal of computer vision is to model, replicate and, more importantly, exceed the human vision using computer software and hardware at different levels. Computer vision systems are commonly used in many fields such as Science, engineering, and industry. Their applications allow automating many scientific and technological process.

Image processing is a technique to enhance raw images received from cameras or sensors placed on satellites, space probes and aircraft or pictures taken in normal day to day life for various applications. Image processing systems are becoming popular due to easy availability of powerful personal computers, large size memory device, and graphic software. There are two methods available for image processing which is analog image processing and digital image processed. But, this project was focused on digital image processing. The term digital image processing generally refers to the processing of a two-dimensional picture by a digital computer [5]. In digital image processing, a digital computer is used to process the image. The image will be converted to digital form and then process it. It is defined as subjecting numerical representations of objects to a series of operations in order to obtain the desired result.

Image processing or analysis involves a series of steps, which can be broadly divided into three levels: low-level processing, intermediate level processing, and high-level processing as indicated in figure 2.1.

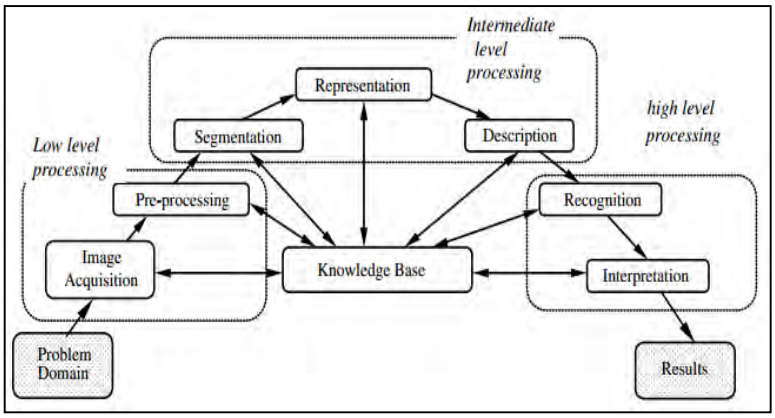

Figure 2.1: Different Levels Image Processing

Figure 2.1 shows Low-level processing includes image acquisition and pre-processing. Before any video or image processing can commercially an image must be captured by the camera and converted into a manageable entity. This is a process known as image acquisition. Image pre-processing refers to the initial processing of the raw image data for correction of geometric distortions, removal of noise, graylevel correction and correction for blurring. Pre-processing aims to improve image quality by suppressing undesired distortions or by the enhancement of the important features of interest. Intermediate level processing involves image segmentation, and image representation and description.

Image segmentation is typically defined as an exhaustive partitioning of an input image into regions, each of which is considered to be homogenous with respect to any image property of interest. For example intensity, color or texture. This process is considered an essential component of any image analysis system and the problem associated with it have received considerable attention [6], [7]. Image representation and description are critical for successful detection and recognition of objects in a scene. After an image has been segmented into object and background regions, one intends to represent and describe them in characteristic feature for computer processing during pattern recognition or in quantitative codes for efficient storage during image compression. Image description deals with the extraction of quantitative information from the previously segmented image regions.

High-level processing involves recognition and interpretation. It is using statistical classifiers or multi-layer neural networks of the region of interest. These