Shape-Based Matching: Application of Defect Detection

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Abstract

This research is regarding to the application of a vision algorithm sensor to monitor the operation of a system in order to control the concerning jobs and work pieces recognition that are to be made during system operation in real time. This paper stresses more on the vision algorithm that mainly focus on shape-based matching application. The algorithm consists of two parts; training phase and recognition phase. The main focus of this paper is to create a region of interest at which they are able to adapt to a variety of applications and purposes depending on the needs of users. The system will be tested using several images that have a variety of characteristic and properties in developing a better system for industrial application. There are three types of glue defect; gap, bumper and bubble are trained through the systems in order to store their own characteristics and properties in the system for matching purposes. The matching process will take place for determine the results occur in recognizing the defects after gluing process being done.

Keywords: Glue defect; gluing process; matching process; region of interest.

1. INTRODUCTION

In this paper, the most important applications used are shape-based matching using HALCON [1]. This application has the effect that this approach is able to handle changes in illumination, clutter, varying size, position and rotation, or even the relative movement of parts of the template projected, multiple instances can be found and multiple models can be used at the same time.

Shape based matching algorithm has 7 fundamental steps which are image acquisition, image pre-processing, image segmentation, extraction of low-level feature, grouping or mapping to high level feature, image classification and image interpretation [2]. The crucial part is on image segmentation which is involved of de-noising technique. The segmentation procedure brings the process a long way toward successful solution of imaging problems that require objects to be identified individually. On the other hand, weak or erratic segmentation algorithms almost always guarantee eventual failure. Image segmentation involves a various type of command that will lead to smoothen of the image as a result for easier execution in recognition system.

Vision-based inspection of industrial products offers low-cost, high-speed, and high-quality detection of defects. Some of the most challenging industrial inspection problems deal with the textured of the gluing process. Defects are common occurred in gluing process. To make sure the quality of gluing process, defects detection and recognition are most popular application used. Many researchers are mostly focused in welding line and also in fabric and many interesting results have been obtained [3-14]. Roughly, all these researchers can be classified as two types, one is based on radiographic inspection and the others based on artificial intelligence. The first kind of methods is to recognize welding defects manually, so the efficiency is much limited [3-5]. The second kind of methods are much better in efficiency, however the complexity of implementation is unnecessary [6-14].

The other research is based on HALCON Application for Shape-Based Matching [15-16]. These papers discuss mostly on the process involved in a basic shape based matching algorithm with additional of extended Region of Interest (ROI) available in HALCON that fulfils shape based matching to find object based on a single model image and locate them with sub pixel accuracy. The basic concept of image matching with addition of Harris Point in the model image is shown in Figure 1.

The other research is focused on the welding defect [10, 14] that uses the feature extraction method to

simplify image to a simple algorithm which is based on the perceptron model to recognize and classify the defects according to the data captured from the extraction method. Image of welding line is very important to the feature extraction and defect recognition in order to recognize and classify the welding defects accurately.

In all the above research, the machine vision system has two common similarities, first is the three basic framework of the process involved; image acquisition, preprocessing and feature extraction. The second one is the two main phase in shape-based matching algorithm which is training and recognition phase. In the above research, it seems that most model based vision programs are developing for a specific task and the environment explicitly coded into the system.

2. RESEARCH METHODOLOGY & DESIGN

2.1 Method

The main idea of this research is to recognize defects after the robot finish perform glue operation according to the specification given by the vision sensor. In order to develop a system that required intelligent in detecting defects, it's consists with too many techniques can be used but there is a wide range of different algorithm concept that each has its strengths and weaknesses. From all of these algorithms, shape-based matching algorithm was chosen to be used in this research. This is because the requirement of this research is mainly on the inspection of a constant and repetitive type of image. Besides that, because of the wide range of applications that might occurs, shape-based matching which takes only the outline edges of an object into considerations are the best fit for this research since everything has a shape.

The vision system in this research used based on HALCON software, which is provides a broad vision library which is very useful that can be manipulate into the system that meet our requirement. The proposed system is based on 2 phase; training phase and recognition phase. In training phase, it provides the application for users to determine all the training parameter of the model images. Then the image will be extracted according to the needs of defect classification in order to generate the system faster and saved it as a template for matching purposes. At the recognition phase, the image then is being fed into the system for matching the image with the template that is already being created in the training phase. The suggested vision algorithm is shown in Figure 1.

This method is proposed to provide an additional system using vision sensor in industrial application. Vision system was known as the analysis of images to extract data for controlling a process or activity. Therefore the most important part in this algorithm is determining the training parameter (User defines as feature extraction). Feature extraction is one of the special tools for extracting image size according to the needs of the system in order to ensure that the processing time of the system will reduce. Region of Interest (ROI) is used in this algorithm because of its special ability that the user manually determines the training parameter just by clicking on the mouse. Hence, it provides the easier way to the user according to system specifications.

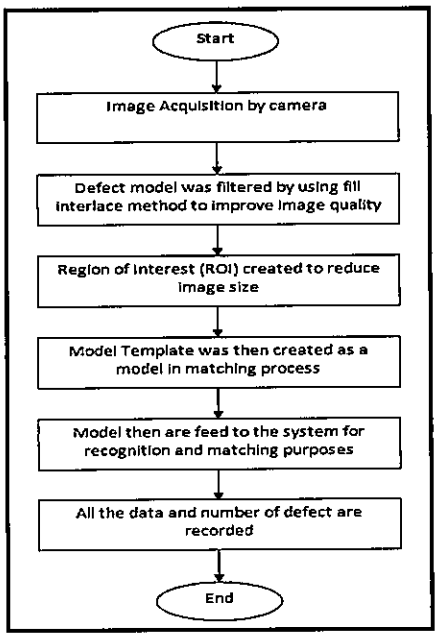

Figure 1: Suggested vision algorithm

2.2 Design

Vision system is applied to give better services for commanding the system for producing a better product at the end of the system. This research consists of 3 main parts: optic apparatus, working field and main computer. All the arrangement of this apparatus is shown in Figure 2.

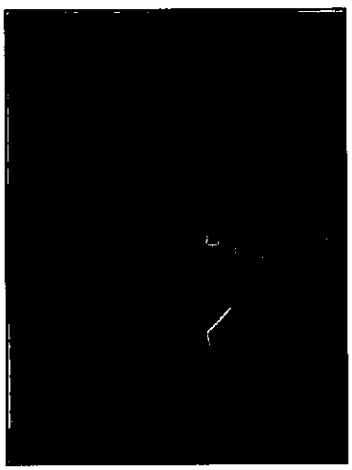

Figure 2: Development of experiment

Optic apparatus is the most important parts in the vision system because it's provide a vision like human

being that able to record what they are seen for the next step of the system. Webcam 12.0 Megapixels is being used as a vision sensor and placed at the top of the object for a better result in getting a complete view of the object for easier to process. The quality of the image is good because of the higher pixel of the camera. The better quality of the images results on the fastest processing time. Reducing the process time increased the performance also benefits to the company.

Working field involves with the object and also the background of the system. Object that being used is a pyramid that manually develops using a white cardboard and the background using a black cardboard. The combinations of colour are used to give a better vision to the system for recognizing the object. With the contrast of the image differs each other, easy for the system differentiate between the object with the background and allows the system run the program smoothly without any problems. 3 models are used as a reference image for matching the image which are gap defect, bumper defect and bubble defect. The model images are shown in Figure 3.

These model images will be train using 2 main steps which are preprocessing and feature extraction. Then, the models unique parameters are stored in the memory for able in recognizing phase. The result image after the gluing process is then goes through the inspection part to check whether there is any defect or not. At this point, all the model images are feed to the system in order to inspect the result image and locate all the defects occur with their own location provided.

Main computer is used as an agent to operate the entire process to ensure everything runs smoothly. Graphical User Interface (GUI) used to interact with the program in getting a clearer picture of the results obtained. All the results of experiments are carried out is displayed on the main computer screen with the help of GUI.

2.3 Template Creation

Template creation is important in determining the originality of the image characteristic to be submitted into the system for matching purposes. Before that, the reference image being limited into certain area that will be used as image identity by using Region of Interest (ROI). During the template creation step, the size of the required features must be considerably large so that the created outline does not overlap as this can cause inaccuracy.

In order to achieve good template matching results, the pixel value difference between the object and the background must be sufficient for the system to work effectively. During the training step, the resultants template must have an obvious shape. The training templates for this experiment are shown as example in Figure 3.

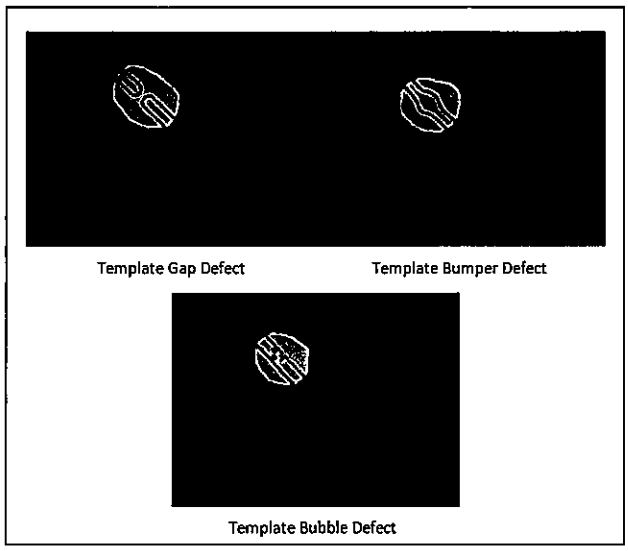

Figure 3: Reference and template creation

5. Discussion of Results

Using Shape-Based Matching technique and recognition algorithm put forward in this paper, 3 types of glue model defect are created as a medium for obtaining defects after glue process is completed. 10 tested images used for testing whether the algorithm able to detects the glue defects or not. Each defect that is recognised by the system will provide with its own positions act as a row and column coordinates. These parameters are important for correction after the classification of defect is complete. The correction will takes place by using the KUKA arm robots according to the position that are obtain through the system. Figure 4 until 6 shown the tested images that gone through the system and Table 1 is shown all the 10 tested images that gone through the inspection system. All the results are presented using the Graphical Using Interface (GUI) to give a better view of the system.

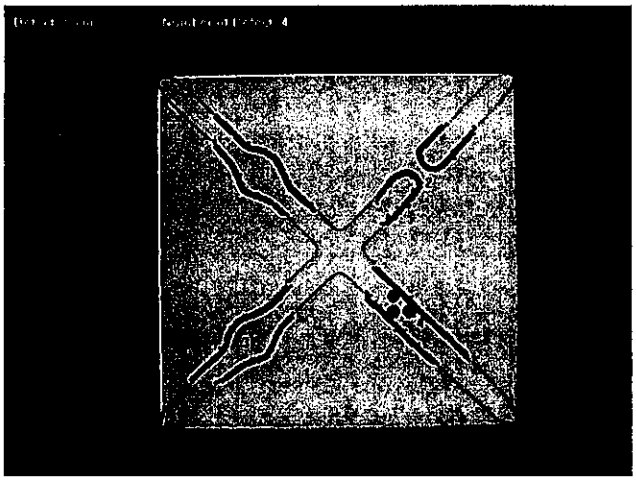

Figure 4: First tested image

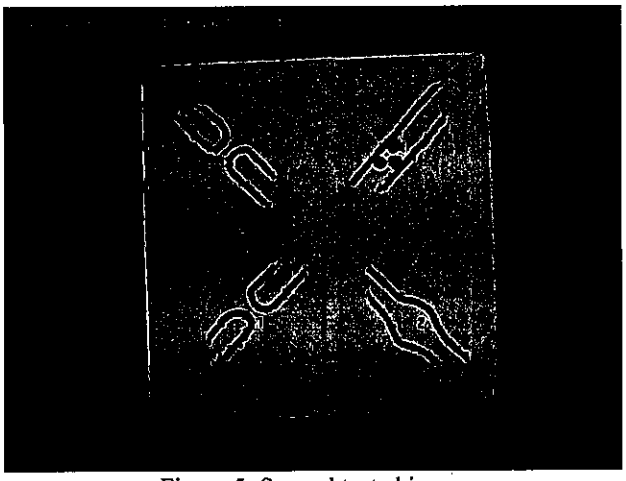

Figure 5: Second tested image

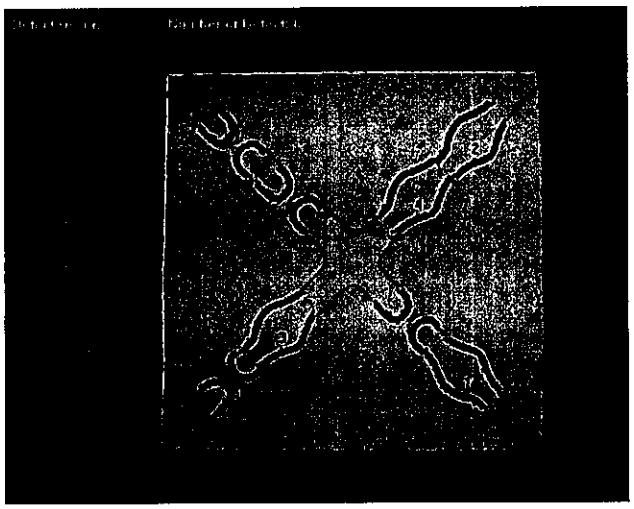

Figure 6: Third tested image

Table 1: Results of inspection system

Image Tested	Total Defect	Defect Detected	Defect Detected (%)
1	4	4	100
2	4	4	100
3	8	8	100
4	7	6	85.71
5	5	5	100
6	8	7	87.5
7	4	4	100
8	6	6	100
9	7	7	100
10	8	6	75
Total	61	57	93.4

The aim of this paper is to present a flexible visual system for shape based matching. Addition of feature extraction, Gaussian smoothing, template creation and template matching are proposed through this paper. Experimental results are used to verify the proposed approach. In this experiment, three defects models and their corresponding samples are used to examine this approach. Table 1 shows the corresponding results according to 10 tested images used. Each tested image has its own defect to be recognised by this system. All the data are recorded into Table 1.

Table I shows the result of defect matching by using 10 tested images. According to the results, the recognition rate of the experiment about 93.4% based on 3 model defects created through the system. This recognition rate shows that the higher accuracy can be achieved through this method. But, with the increasement of the training samples, the recognition rate would be much better.

6. CONCLUSION

Auto recognition of gluing defects is a useful research with strong application background. In this paper, a method that is used to extract features of defects and auto recognizes defects are put forward. Experimental results show that the recognition rate achieved about 93.4% that much better for acquiring defect detection in gluing lines. Generally the method of recognition and classification of defects in gluing lines are effective. And it can much reduce the working effort of human being and increase the defect recognition efficiency.

7. FUTURE PLANNING

This project will be continued further by applying the system with the assisting of KUKA arm robot for gluing process and do the correction when defect occurs during the inspection. The system will consist of a KUKA arm robot and a main pc that control the whole systems including the matching and inspection system. Simple pyramid will be used as a testing objects; the aim of the project is to show ease of implementation of the vision system in recognizing glue defects and to test its reliability and flexibility during and after the gluing process.

8. ACKNOWLEDGMENT

The authors appreciate the support granted by Universiti Teknikal Malaysia Melaka (UTeM) in pursuing this research.

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