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Flexible Approach for Region of Interest Creation for Shape-Based Matching in Vision System

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***Abstract*— This research is regarding the application of a vision algorithm to monitor the operations of a system in order to control the decision making concerning jobs and work pieces recognition that are to be made during system operation in real time. This paper stress on the vision algorithm used which mainly focus on the shape matching properties of the product. The algorithm consists of two phases, the training phase and the recognition phase. The main focus of this paper is on the development of an adaptive training phase of the vision system, which is the creation of a flexible Region of Interest capability that is able to adapt to various type of applications and purposes depending on the users' requirements. The system was tested on a number of different images with various characteristics and properties to determine the reliability and accuracy of the system in respect to different conditions and combination of different training traits. This system can be applied in industrial sectors especially for process and quality control.**

I. Introduction

A flexible manufacturing system is an adaptive and dynamic system that cater to a wide range of different jobs where each involves a set of operations that are required to be done at a predetermine workstation. Flexible and agile manufacturing is of increasing importance in advancing factory automation that keeps a manufacturer in a competitive edge. Flexibility signifies a manufacturing system's ability to adjust to customers' preferences and agility means the system's speed in reconfiguring itself to meet changing demands. Both together make it possible for manufacturer to respond instantly to the market. To achieve a fully flexible automated system, one of the supporting systems is machine vision. Machine Vision [1] is the application of computer vision to industry and manufacturing sectors, mainly focused on machine based image processing. It is also the study of methods and techniques whereby artificial vision system can be constructed and usefully employed in practical applications [2].

II. Background

In the area of Machine Vision inspection system, a lot of different approached has been studied intensively and plenty of machine vision software are available. B. Mehenni and M.A. Wahab [3] studies on the Automatic Pattern Recognition and Inspection System (APRIS). They divide pattern recognition and inspection problems into two distinct classes, which checks the product for completeness and searching for blemishes and other flaws. They used an ASIC implementation system together with FPGAs based static RAM technology from Xilinx to produce their prototype. Another visual inspection for quality assessment are studied by Piuri V. and Scotti F. [4]. The aim of their research is to develop a defect detection system for melamine laminated particle board. They extract knowledge from the printed matter to guarantee higher defect detection capabilities, the main criteria consider is the texture, color and shape features. Denni Kurniawan and Riza Sulaiman [5] studied the design and implementation of automatic visual inspection system in automatic control system based on Programmable Logic Controller (PLC). The visual inspection system are developed using Visual C++ 6.0 and Vision SDK 1.2 from Microsoft. The aim of their research is to inspect the size of the bottles of the MAPS bottling system. Another research based on HALCON application for Shape-Based Matching is done by Xuebin Xu, Xinman Zhang, Jiuqiang Han, Cailing Wu [6]. They describe the process involved in a basic shape based matching algorithm and the detail programming language used by HALCON.

In all the above research, the machine vision system and software used has two common similarities, first is the three basic framework of the process involved; image acquisition, preprocessing and feature extraction/selection; second is the two phases required for shape matching, the training phase and the recognition phase. In the above research, it seems that most model based vision programs are develop for a specific task and the environment is implicitly coded into the system. Therefore it is difficult to modify the knowledge or extend the scope of such system, and it also requires long development time.

The aim of this research is the design and implementation of a machine vision system for industrial application. The focus of this research will be on shape based matching, selective Region of Interest and various option of matching criteria that can be applied to a flexible manufacturing system, particularly automated visual inspection and vision for automated assembly.

III. Visual Algorithm

The vision system in this research used is based on HALCON, a machine vision software that provides a comprehensive vision library that we can manipulate into a

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new system that suits our requirement. The basic concept of image matching is shown in Figure. 1.

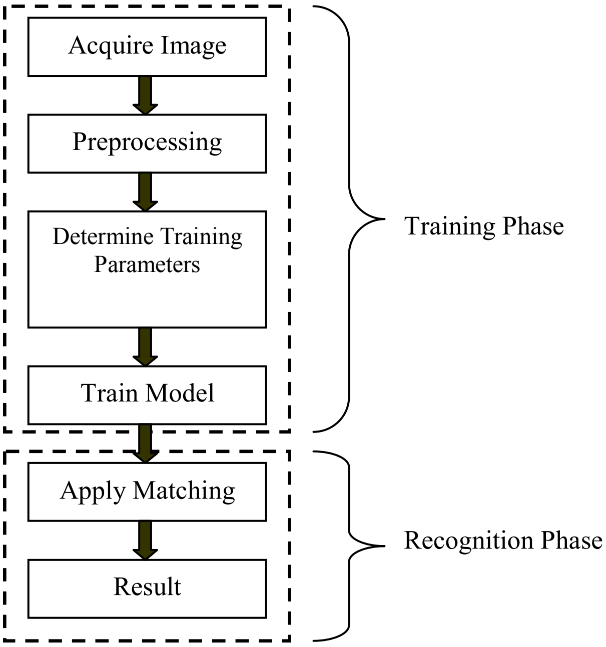

Fig.1: Basic framework for image matching

At the training phase, after all the training parameters are determine by the user, an edge detection library are applied to extract the edges of the image, these edges are then saved as a template that will be used for the recognition phase. At the recognition phase, images are then fed to the system to be matched against the template that was created in the training phase.

As stated above, the aim of this research is the design of the vision algorithm so that it is able to be implemented in a Flexible Manufacturing System. Without the pre-knowledge of the objects that are going to be applied, the system is designed to be flexible and smart so that it can be applied without much modification. Therefore the focus will be on the Determine Training Parameters Phase, which will be divided into smaller sections.

TRAINING PARAMETERS

In order to achieve flexibility and uncertain changes, the main training parameters are determined by the user manually which are located at the user interface.

A. *Feature Selection*

Feature Selection is a very important part in this system. It not only enables the user to select the critical features, it also minimizes the size of the required matching template therefore saving computation time and operation process. The Feature Selection is done by creating a Region of Interest (ROI), the program is written so that the ROI can be created freehand by using mouse. Furthermore, multiple ROI can be created and combine into one complex ROI.

The compelling reason for using multiple ROI is because we are able to extract the object from the background by selecting only the critical criteria that is required to differentiate the wanted object from the background.

B. *Matching Parameters*

The matching parameters included are rotation and scale. These matching parameters can be included according to the user preferences. For example, if the rotation parameter is enabled, the search of a matching object can be in any orientation, if the rotation parameter is disabled the search of a matching object must be in the same orientation of the object trained. As for the scale parameter, when enabled matching object can be in different scale and when disabled the matching object must be of equal size with the object trained.

C. *Multiple Model*

As one of the requirement for FMS, multiple object recognitions are a necessity. Therefore the vision algorithm must be able to train and recognize multiple and different objects. When different objects are trained, each model's template is stored separately

D. *Quantity Search*

Additional function is added to enhance the system capability, quantity search allows user to set the number of products that they desired. The search will only be true if the required number of products is found.

IV. DISCUSSION OF RESULTS

The potential of the proposed visual algorithm system was the flexibility of the program to accommodate changes.

At the Feature Selection section, firstly we look at the significance of multiple selective ROI. The system is tested on an image that consist of a combination of objects of different shapes and different color which will be interpreted into corresponding grey levels in the system. The test was performed by providing two images that will be used as the main testing image for this system. The two testing images are as shown in Figure 2 and Figure 3.

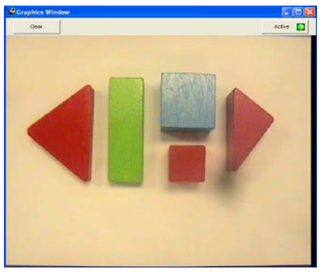

Figure 2

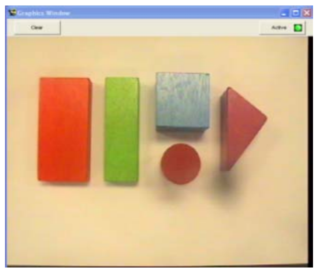

Figure 3

Both Figures show five shapes with different colors, the different is the triangle and square shape in Figure 2 and the rectangle and round shape in Figure 3. Therefore to differentiate these two images, we can create a ROI to minimize the training parameters instead of taking in considerations of the whole image. The sequence of the process is as shown in Figure 2a, 2b, 3a and 3b.

The first step is to create the ROI, the ROI is drawn by holding the left mouse click while circling the wanted shape.

After selecting the ROI, all other image not in the ROI will be removed. The image selected will then go through the vision algorithm for further processing.

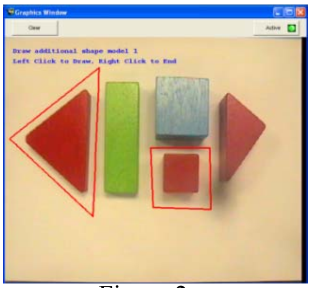

Figure 2a

Figure 2b

Figure 2a: The ROI creation in feature selection section.
Figure 2b: Resultant image of extracting the ROI image

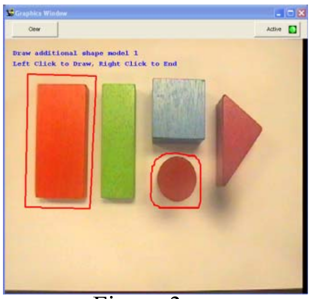

Figure 3a

Figure 3b

Figure 3a &3b: The same process is applied to Figure 3.

Major advantages of multiple selective ROI is that the user can decide on the criteria that they required from a combination of different ROI as one object or each ROI as separate objects. An experiment has been done to test the flexibility of the program, a DIP switch has been selected as the main object for this experiment.

Case 1. Checking the Number Of Switches

In this case, the program is train with the reduce picture of the switch of the DIP Switch. The program will then search for the switch when images are feed to it. The reference image is shown in Figure 4,

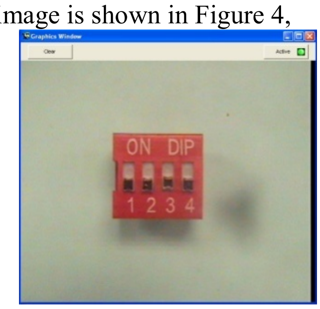

Figure 4

Figure 4: The reference image of a DIP switch used in the experiment.

Start with capturing the image, we then draw the ROI using mouse around the wanted object. The image containing the wanted characteristic will be used as matching template.

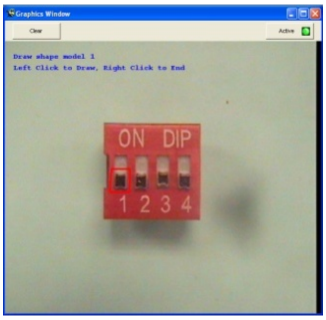

Figure 4a

Figure 4b

Figure 4a: The ROI creation
Figure 4b: The extracted image from the ROI

The matching process is done by using several different switch position configurations and the results are satisfying as long as the object is in the work area. Figure 4c, 4d and 4e shows the result when different images are feed to it.

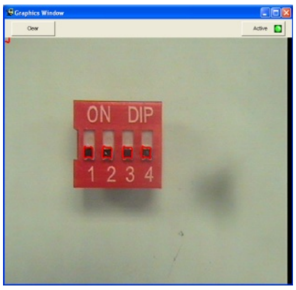

Figure 4c

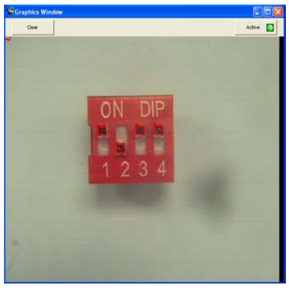

Figure 4d

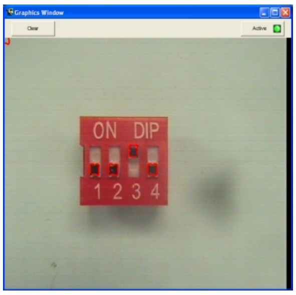

Figure 4e

Figure 4c, 4d & 4e: Results of the test image.

Case 2. Checking the Position Of Switches

In this case, the program is train to detect the required switch configuration, which is switch 1 and 3 must be on, the other two switch 2 and 4 can be in any configurations.

The reference image is shown in Figure 5. Figure 5a shows the ROI creation and Figure 5b shows the extracted image used to train the system.

Figure 5

Figure 5: The reference image of a DIP switch with switch no 1 and 3 at the on position being used in the experiment.

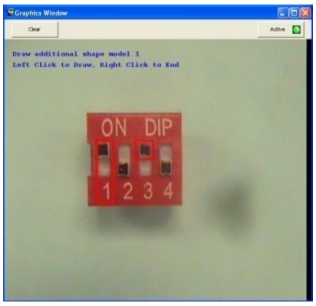

Figure 5a


Figure 5b

Figure 5a: The ROI creation
Figure 5b: The extracted image used to train the system

The ROI consists of the number 1 with the on position of the switch above it and the on position of the switch 3. The Number 3 is not included because both small ROI combined into one ROI causing the distance of the two switches to be set still.

Object detection is achievable as long as the position of switch 1 and 3 are at the on position. With no concern on the switch position of the other two switch. Figure 5c, 5d and 5e shows image that satisfied the above conditions while Figure 5f shows image that does not satisfy the above conditions. Object is no longer detected when the switch position is not at the required position.

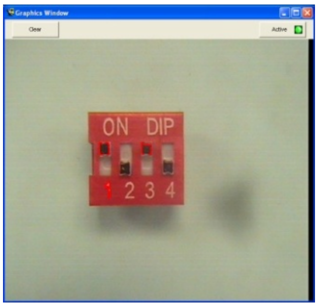

Figure 5c

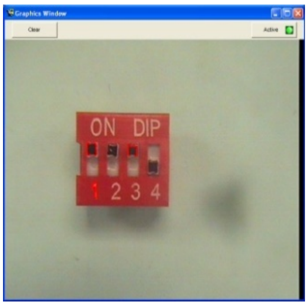

Figure 5d

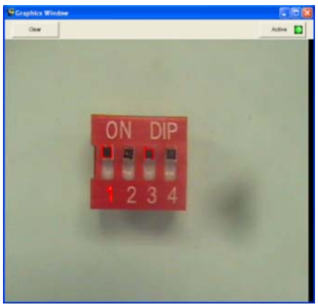

Figure 5e

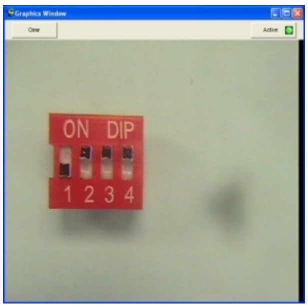

Figure 5f

Figure 5c – 5f: The images used to test the system and its results.
Figure 5c – 5e: Images are successfully detected as long as switch 1 and 3 are at the on position.
Figure 5f: The image is not detected because the required characteristics are not meet.

V. CONCLUSION

The aim of this paper is to present a flexible visual system for shape based matching. In this paper a concept for a flexible ROI creation visual system was presented where the parameters and characteristics can be easily determined by the user. The proposed visual algorithm concept is easily adaptable and extendible, so that this program can be used in most situations as seen fit by the user. This innovative approach allows the user to select and adapt the system according to their requirements.

VI. FUTURE PLANNING

This project will be continued further by applying the system to a simple pick and place system. The system will consist of a conveyor belt with pick and place arm that is control by PLC. The vision system which is in PC with be connected to the PLC to act as the feedback to control the process and decision making of the PLC. Simple wooden blocks will be used as the testing objects; the aim of the project is to show the ease of implementation of the vision system and also to test its reliability and flexibility.

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