The PCB Defect Inspection System Design Based on Lab Windows/CVI

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Abstract— **A novel approach used for Printed Circuit Board (PCB) defect inspection is presented in this paper. This image processing approach that developed in Lab Windows/CVI can be used to determine whether PCB components are put in the correct location, and matches areas of inspection to a template of valid components. The experimental result shows that the proposed approach can search the correct components in PCB image with a given template, therefore it can be used in an automatic optical inspection for on line inspection.**

Keywords-PCB; inspection; image; pattern matching; defect; LabWindows/CVI

I. INTRODUCTION

The defect detetion, particularly the visual inspection on manufactures is extremely important in the optimization of industrial process. Many researchers have been engaged to develop automatic analysis processes of manufactures and automatic optical inspection in the industrial production of printed circuit boards [1].

PCB detection has experienced from visual inspection that carried out by human expert to automatic detection. Nowadays, defects are commonly detected by the in-circuit test (ICT) , the functional board test (FBT), the automatic optical inspection (AOI), the most commonly used equipment of PCB detection system is AOI system[2].

For PCB production process is complex, with many steps, and at each step different defects may occur, for example, paste missing and paste bridges in the solder printing step; part missing and misoriented parts in the pick and place step; and faulty solder joins in the reflowing step. It is highly beneficial for these defects to be detected in an early time, practice shows, if a defect not find at a step in the whole production process, afterwards to remove this defect may multiple the cost [3]. So it is important to work out a reliable method to detect the defects of the PCB, and apply it in automatic optical inspection to do the detection on line.

In this paper, we inspect the defect of PCB by pattern matching. We develop the program in LabWindows/CVI. With IMAQ function library, we can process PCB images conveniently, and by pattern matching, we can find out weather PCB components are present and in correct location.

II. SYSTEM STRUCTURE

In this section, we introduced the structure of the inspection system.

All AOI-based system are constituted by an acquisition system and a processing system.[3] The acquisition system includes a CCD sensor and a image acquisition board, this part take charge of acquiring the image and changing it into digital information. The processing system concludes preprocessing and other image processing.

There are four steps to do the detection: image acquisition; preprocessing; feature extraction and pattern matching, as showed in figure 1.

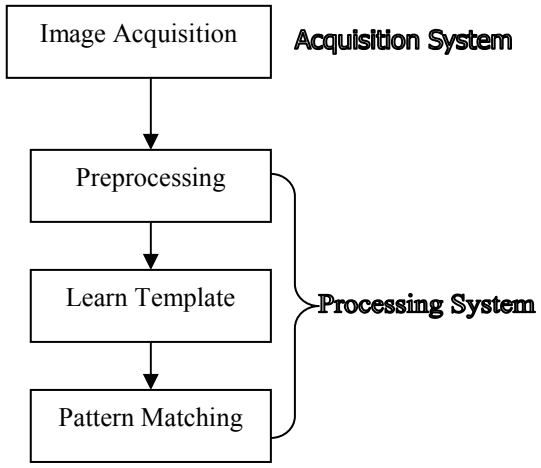


Figure1. Procedure of the inspection

Processing system is based on LabWindows/CVI. LabWindows/CVI is a software development which was developed by National Instruments Corporation, it has plenty of functions in function library for C programmers. Particularly suitable for develop automatic detection system, data acquisiton system and predure control system. With IMAQ function library in LabWindows/CVI, we can develop an image processing based inspection system much more conveniently and easily.

III. METHOD OF ISPECTION

A. Preprocessing

The aim of preprocessing is to remove noise and enhance the useful information, at the same time, to recover the degradation phenomena of the image that caused by inputting measure equipment or other factor [4].

There are many methods to enhance the image, such as contrast enhancement, modify histogram enhancement and smoothing. For histogram modification and

enhancement can not only increase the contrast, but also remove noise, so here we enhance the image by modifying enhancing histogram.

For the patter matching is based on grey image, if the image acquired is RGB image ,we change it into grey followed with standard average method. Set R,G,B as the components of red, green and blue in RGB image, so the grey value is[5]:

g = 0.3R+0.59G+0.11B

Set the pixels number of the source image f(x, y) as N, and it has 256 grey-level.

The transform formula of histogram homogenization is as follows:

If the grey of the source image (i, j) is r_k, the grey after histogram homogenization is

$$s_k = T[r_k] = \sum_{l=0}^{k} \frac{n_l}{N} = \sum_{l=0}^{k} h_l = s_{k-1} + h_k$$

(k=0, 1, … , L-1)

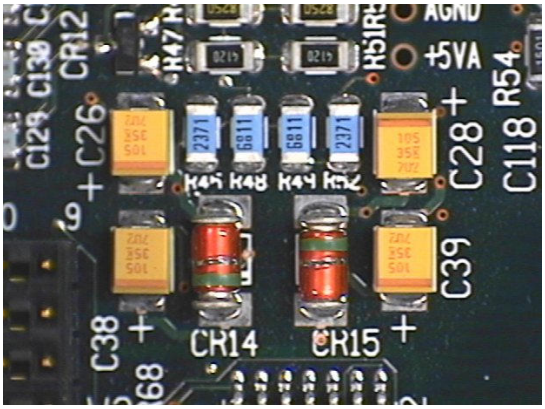
r_k : grey of the k^{th} grey-level;

n_k : occurrence frequency of r_k ;

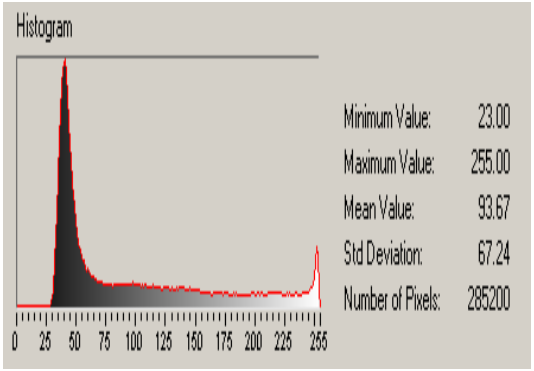
N: the pixels number of the source image;

L: the grey-level, here is 256.

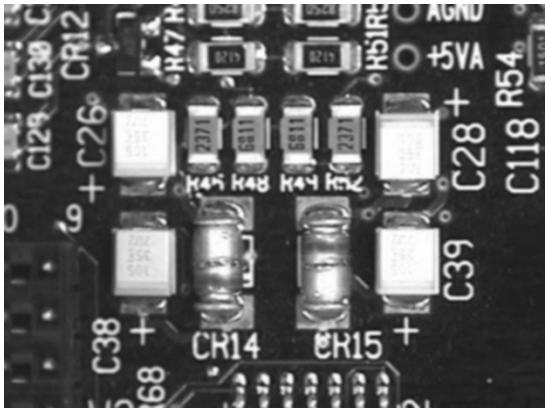
The PCB image used for test is shown in Fig. 2 (b), (c) is the source grey image after transformed and (d) is the image after enhanced.



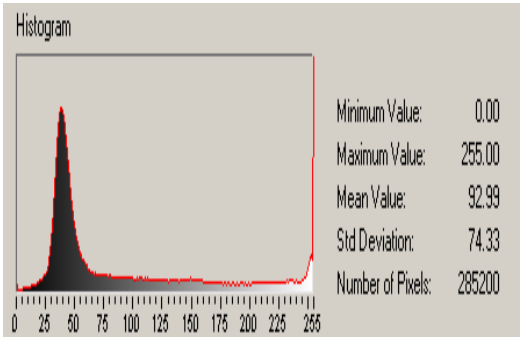
(a)



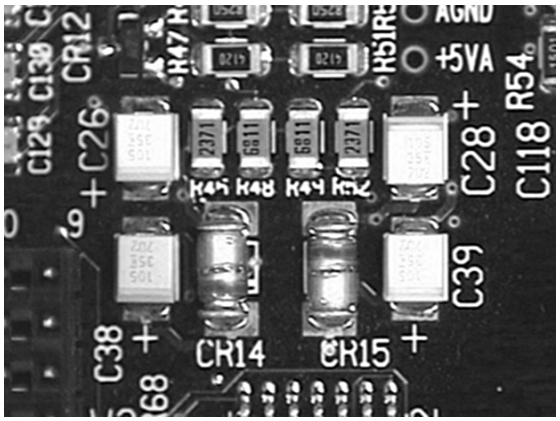
(b)



(c)



(d)



(e)

Figure2. Histogram and image (a.,b source image; c,d preprocessed image)

B. Learn Template

Before pattern matching, we should give the information about which component do you want to detect. That is to say we should learn the template first then search the matching area in the test PCB image.

The function used is as follows:

imaqLearnPattern (templateImage, IMAQ_LEARN_ALL);

We save the template as a image file, so it can be displayed as a image with the test image as showed in Figure 3.

C. Pattern Matching

IMAQ function is used to finish the pattern matching, including learning a template and searching a temple. The

template can either create from the source image or can load from file.

The function used is as follows:

imaqMatchPattern (searchImage, templateImage, &matchOptions, IMAQ_NO_RECT, & numMatches)

Test result is shown in figure3, it has the quality of shift and rotation Invariant. The rectangle in red is what we search for.

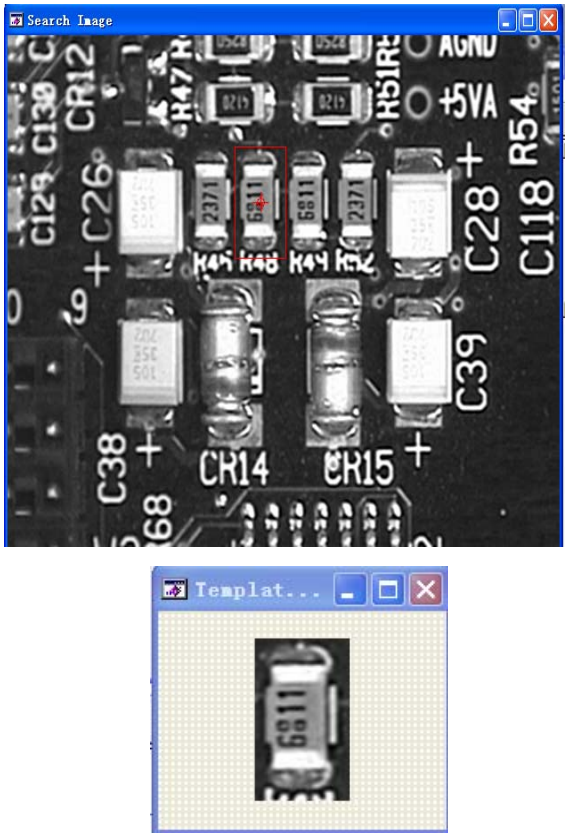


Figure3. Pattern Matching

IV. CONCLUTION

As PCB inspection is so important in manufacture industry, it already has a long way to go both on hardware and software.

The method proposed in this paper can detect the component and location default by pattern matching efficiently, but it is far from perfect, we desire to develop a inspection system with LabWindows/CVI which can find out most of the normal defects on PCB, such as paste missing and paste bridges, solder joints, and so on. And applied it with AOI system make on-line detection much more reliable.

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