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Fault Detection of Assembled PCB through Image Processing using LabVIEW

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***Abstract*—Printed Circuit Boards (PCB) plays the important role in the development of electronic devices. PCB provides mechanical support and electrically connects electronic components using conductive tracks. Faults in the PCB may cause the entire system failure. It is necessary to identify the faults in the PCB's before installing to the system. Fault detection of wrong component in the assembled PCB is very important. This is one of the important stages which give the results of PCB processing. There are many techniques are used in fault detection and for missing components in the assembled PCB. In this paper we present the Automated Inspection System for assembled Printed Circuit Board. Automated inspection system implemented using template matching technique to inspect the assembled PCB and to find the missing components. It is very fast and accurate. It detects of any missing components, verify the physical dimension of the component and detailed check sheet extracted. This current work LabVIEW NI vision software has been used to implement PCB inspection.**

***Keywords*—PCB, Automated Inspection, Image Processing**

I. INTRODUCTION

Missing components and fault in the mounted PCB is usually done by visual inspection. Visual inspection is time consuming and not possible to get the non defect PCB. Because visual inspection is carried out by the humans and with human eyes it is not possible to find the tiny missing components and missing of conductor strips. To reduce errors and get the non-defect PCB, automated inspection systems are developed.

Inspection of the PCB is carried out in the different stages of PCB manufacturing. PCB defect can be classified into two major groups: Functional defect and cosmetic defect [8]. Functional defects are tested by connectivity test which will affect the performance of the system. Cosmetic defects will affect the appearance of the system. There are three different defects detection technique classified under the automated inspection [7]. Referential approaches: comparing with the reference images, Non-referential approach: Verifying with the design rules and Hybrid approach: it is combination of both referential and non-referential approaches.

Automated PCB inspection system [8] developed to improve the quality of the PCB production and reduce the rejection ration. In this work to find the missing components we use the referential approach. The perfect assembled board is used as the reference board. Inspecting PCB images is the test image. Test PCB is checked against the reference board using template matching method. This method will find the missing components.

II. BACKGROUND WORK

Genetic programming, Image subtraction and correlation are the different technique used to develop the automated PCB inspection.

Xie, A. L. Uitdenbogerd, and A. Song [1-2] showed that Genetic programming is used to find the defects in the assembled components of the PCB. Genetic programming extracts the features of the reference image and compares with the test image. It converts the image into small segments. The segments are overlapped with the test image to find the defective components. To adjust the image with the test image the operation is performed several times. Comparing all the values the final defect area is marked. Equations

Fabiana R. Leta and Flavio F. Feliciano [3] have shown method of Image Correlation for PCB inspection by calculating correlation factor. If correlation value is between the range specified then there is no defect. In image correlation method, exact type of component cannot be asserted.

B. Kaur, G. Kaur and A. Kaur [4,9] define the Image subtraction method. This method is generally used in bare PCB and also in assembled PCB's. Subtraction operation is performed bit-by-bit. It has drawbacks such as more time consumption, and also it requires same size of base image and test image.

Mohit Borthakur, Anagha Latne and Pooja Kulkarni [5] show by comparative study that PCB defects can be identified. They also define different methods of assembled PCB inspection. It is not a generalized system, there for separate code needs to be written for different PCB's.

Jagadish. S. Jakati and Sidramayya S Matad [6] define the segmentation algorithm. Partition of the image is done and then converted to the required format, which is then matched with the reference board. The computer generated board is used as the reference board. This system requires a particular camera specification to detect the defects.

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III. PROPOSED SYSTEM

The Proposed Automated PCB inspection system has been implemented using pattern matching technique and the tool used is LabVIEW. Perfect board image is compared with the reference board images. If there is any variation between the reference and test image is take as fault. The Figure 1 shows the overall flow of the Inspection.

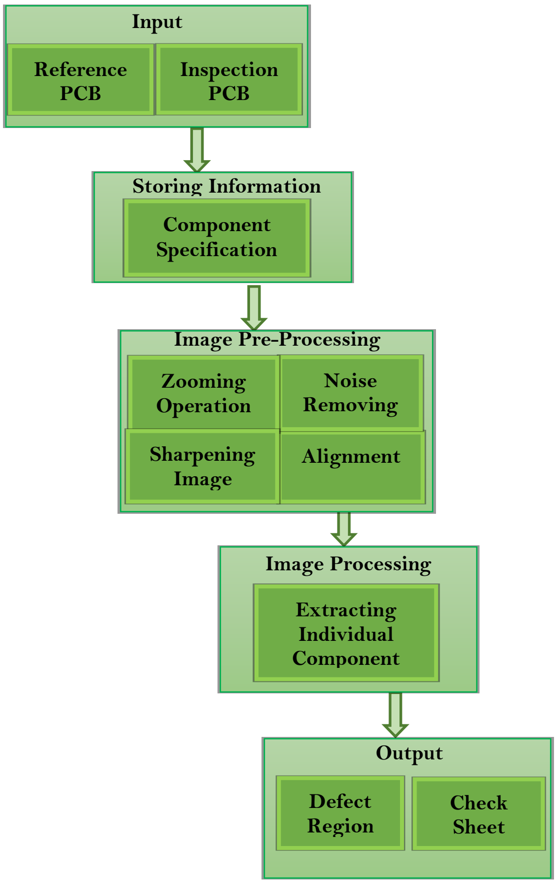

Fig 1: Block diagram of proposed system

The input image is captured using ordinary camera under normal lighting condition. The image is color image having the resolution of 6000x4000. This color image is used directly in the program, there is no need to convert it into any other form. The folder called 'Pics' is created all the images copied to that folder for processing. The program will automatically takes images from 'Pics' folder.

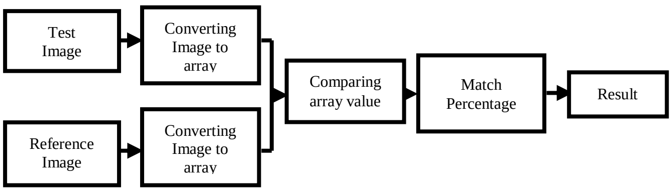

Fig 2: Flow of template matching

The perfect board image DSC_0725 is the reference image, this board is verified against the design rules and standard specification. All other images of the board are the test images. The image name used as the board name in the report.

LabVIEW is data flow programming, has to specify the steps of execution. First step is initialization, in that specifies the path of the program and the for the output report number of rows and columns. The path of the pics folder automatically searched by the program. For the template matching need to specify the percentage of match, brightness, shape etc. This values are given to the 'Setup Match Color Pattern' icon is shown in figure 3.

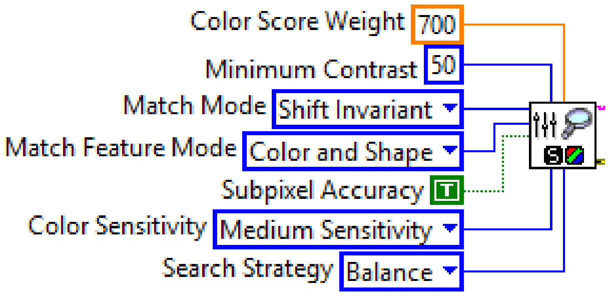

Fig 3: Setup Match Color Pattern values

The reference and test images are taken both image is converted to array values. The color image is converted to the array value, this value is represented in 32 bit for each pixel. The reference image array value is overlapped on the test image. To adjust with reference image the VI will guide where to start image. If the match percentage is below and the shape is not matched the board is failed.

From the reference board individual component images are extracted. To extract the component images position and details are given as input. This is called as training, one of the important stage. The same method implemented, image is converted to array and checked. The component image matric and reference image matrix is over lapped. For checking individual component bit different. The component may be vertical or in horizontal to match that image has to be rotated. Figure 2 shows the flow of template marching technique and Figure 4 shows the screen shoot of the LabVIEW coding. All the component checked, it will take the count of the components also.

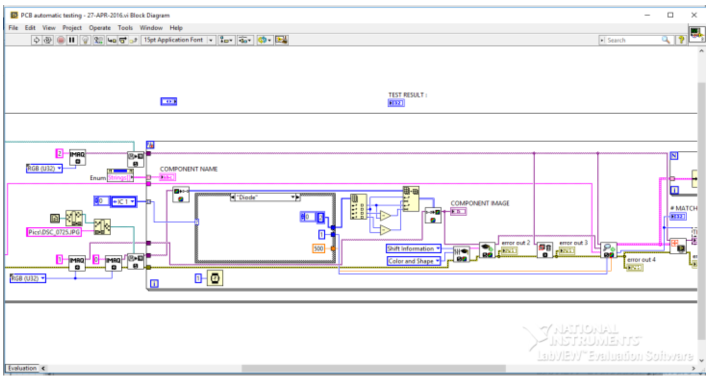

Fig 4: LabVIEW code

To adjust the test image with the reference image, the position information is given. This position information is given from the Sub VI. Sub VI is created to speed up the operation. Sub VI will give the line values, multiple values are taken and this multiple line are forms image. This sub VI screen shoot is show in figure 5. By using this the PCB board is checked.

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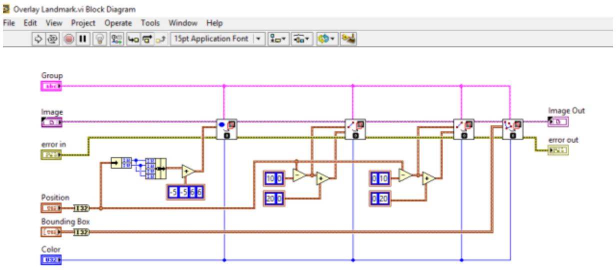

Fig 5: Sub VI Program

After checking overall board the result is tabulated in the table. The exact number of components present in the board is mentioned in the left side of the front panel of the PCB test window. This is compared with the results of test image. According this comparison result of the board is decided passed/failed. This results can be extracted to the word format and documented for the future process. Figure 8 shows the test window.

IV. RESULTS

The automated PCB inspection is carried out for 16 images. It checks the PCB in 1 minute 40 seconds. It is very fast, which displays the component image and the test image is as shown in figure 8. It will check all components. The result window consists the table which records the results, component under test box displays the component one by one at present it checking. In the test PCB position of the components are highlighted in the images. If the position information is required can be extracted separately. The result is tabulated in table. The table contains components in column and the PCB name in the rows. Table filed with the count of the component in the each board.

The result can be extracted to word format. This is added with the extra column which tells result that the board is Passed or Failed. Figure 9 shows word format of the result sheet. Output of the project is Detection of any missing components, Physical dimension of the component is verified and detailed check sheet extracted. The figure 6 shows the test image and figure 7 shows the image with the IC missing.

Fig 6: Image of referance board

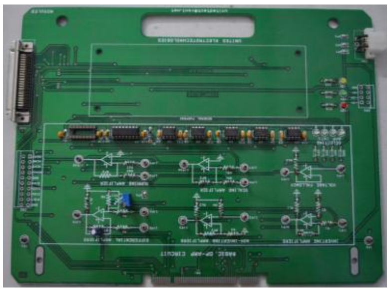

Fig 7: Image of test board IC missing

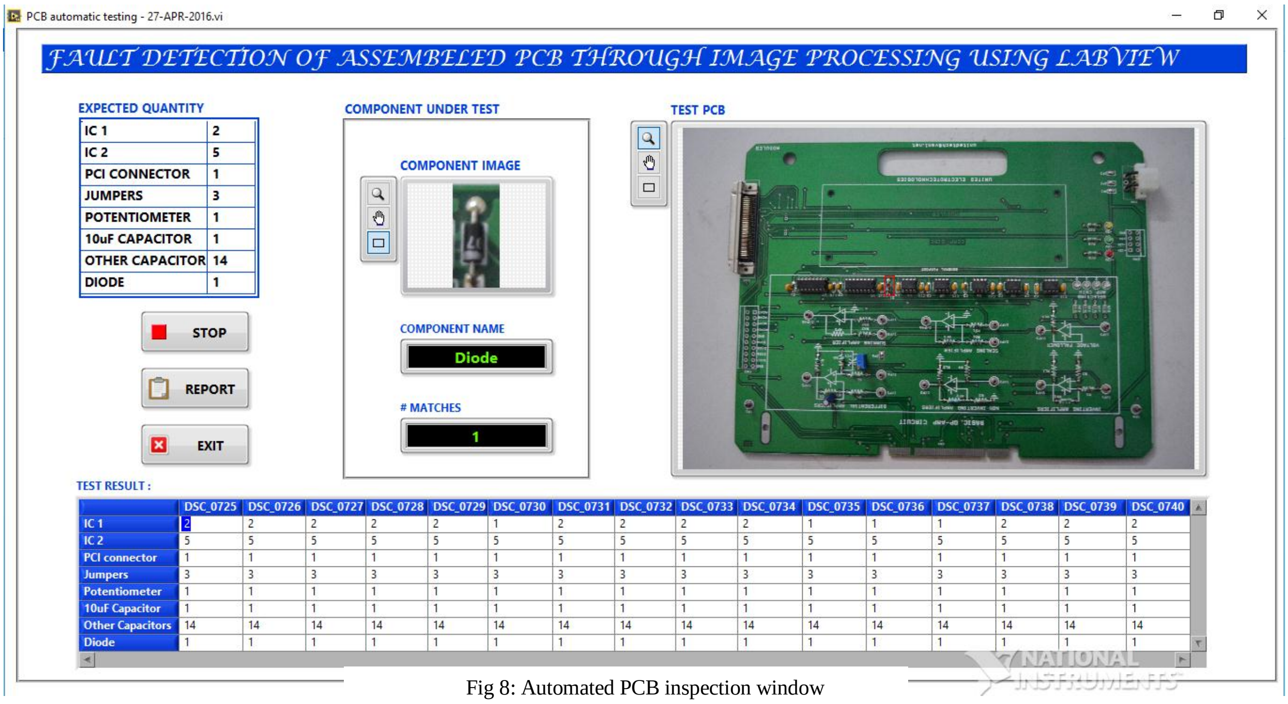

Fig 8: Automated PCB inspection window

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AUTOMATED INSPECTION OF PRINTED CIRCUIT BOARD

	IC 1	IC 2	PCI connector	Jumpers	Potentiometer	10uF Capacitor	Other Capacitors	Diode	STATUS
DSC_0725	2	5	1	3	1	1	14	1	PASSED
DSC_0726	2	5	1	3	1	1	14	1	PASSED
DSC_0727	2	5	1	3	1	1	14	1	PASSED
DSC_0728	2	5	1	3	1	1	14	1	PASSED
DSC_0729	2	5	1	3	1	1	14	1	PASSED
DSC_0730	1	5	1	3	1	1	14	1	FAILED
DSC_0731	2	5	1	3	1	1	14	1	PASSED
DSC_0732	2	5	1	3	1	1	14	1	PASSED
DSC_0733	2	5	1	3	1	1	14	1	PASSED
DSC_0734	2	5	1	3	1	1	14	1	PASSED
DSC_0735	1	5	1	3	1	1	14	1	FAILED
DSC_0736	1	5	1	3	1	1	14	1	FAILED
DSC_0737	1	5	1	3	1	1	14	1	FAILED
DSC_0738	2	5	1	3	1	1	14	1	PASSED
DSC_0739	2	5	1	3	1	1	14	1	PASSED
DSC_0740	2	5	1	3	1	1	14	1	PASSED

Fig 9: Detailed Report format

V. CONCLUTION

It has found that the Automated PCB inspection system will reduce the time taken to detect the defects significantly. It helps in increasing the production by speeding up the inspection process with accurate results. Easily identify the missing components generates the check report for maintaining the records and further actions.

This automated inspection system can be implemented in low cost. Small scale industries can adopt this system to reduce the time of inspection and minimize the errors.

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