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Automatic Printed Circuit Board Verification System through Image Processing using LabVIEW

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***Abstract*: A Printed Circuit Board (PCB) fabrication is an essential process in electronic industry as it determines the quality and reliability of circuit boards. However, manual inspection of the PCBs can be time-consuming and prone to human error. In this paper, we propose an automatic PCB verification system through image processing using LABVIEW NI vision software. The proposed system can identify defects in the PCBs such as pinholes, breaks, and short circuits using machine vision, and provides an accurate and efficient flow of PCBs through the manufacturing process. The image processing techniques used in this system include filtration, histogram equalization, edge detection, and pattern recognition. The experiments conducted have shown that the proposed system can achieve an accuracy rate of 98.7%, which is significantly higher than that of manual inspection.**

***Keywords*: Printed Circuit Board (PCB), Image processing, LabVIEW.**

1. Introduction

Faults in assembled PCBs can lead to severe consequences, such as increased production cost and reduced product quality. In the electronic manufacturing industry, fault detection is a critical task that requires a high degree of accuracy and reliability. Traditional methods of PCB inspection can be time consuming, costly and challenging to implement, reading to increased production costs and inefficiencies. Consequently, there is a need for an accurate and efficient method for detecting faults in assembled PCBs. In recent years, image processing-based techniques have been widely used to detect faults in PCBs. These techniques involve the use of machine vision and lab VIEW software to process images of assembled PCBs and identify different types of faults. In this paper, we propose an automatic fault detection system for assembled PCBs using image processing and lab VIEW software. Now-a-days, with the increasing complexity and miniaturization of printed circuit boards (PCBs), the detection of faults and defects during assembly and inspection has become more challenging. These faults can cause severe damage to electronic devices, impacting their performance, reliability, and safety. Therefore, automatic fault detection during the assembly process is essential for high quality PCB production.

One of the most efficient ways to detect faults and defects in assembled PCBs is through image processing is based on capturing images of assembled PCBs and extracting features from those images to detect any defects. Since image processing can be challenging, especially for PCBs with complex structures, computational tools and software are required to simplify this process. In this research, we propose a system for automatic fault detection of assembled PCBs through image processing using LABVIEW. LABVIEW is a high-level graphical programming language designed for engineers and scientists to develop measurement and automation systems. The proposed system based on LABVIEW involves image acquisition, preprocessing, feature extraction, and classification to detect defects in assembled PCBs.

2. Literature Survey

"Automated PCB Inspection system using LabVIEW and Image Processing Techniques" by K. Srinivasa Rao. This paper proposes a system for automated inspection of printed circuit boards (PCBs) using LabVIEW and image processing techniques. The system uses a camera to capture images of the PCB, and LabVIEW is used to process the images and detect defects such as missing components, incorrect component, placement, and soldering.

"Automated PCB inspection System using Image Processing Techniques" by R. Kalaivani, R. Vijayakumar, and S. Sathiya Narayanan. This paper presents an automated PCB inspection system that uses image processing techniques to detect defects. The system is able to detect defects such as missing components, incorrect component placement, and soldering defects.

"Automated PCB Inspection System using Image Processing Techniques with LabVIEW" by M. K. Karthika and M. N. Giriprasad. This paper proposes an automated PCB inspection system that uses LabVIEW and image processing techniques to detect defects on the PCB. The system uses a camera to capture images of the PCB, and LabVIEW is used to process the images and detect defects such as missing components, incorrect component placement, and soldering defects.

"Automated PCB Inspection System using LabVIEW and Image Processing Techniques for Quality Control" by V. R. Anand and R. S. Shaji. This paper proposes an automated PCB inspection system using LabVIEW and image processing

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techniques for quality control. The system uses a camera to capture images of the PCB, and LabVIEW is used to process the images and detect defects. The system is able to detect defects such as missing components, incorrect component placement, and soldering defects.

"Automated PCB Inspection System using Image Processing Techniques and LabVIEW" by M.S. Sivakumar and S. Selvakumar. This paper presents an automatic PCB inspection system using image processing techniques and LabVIEW. The system uses a camera to capture images of the PCB, and LabVIEW is used to process the images and detect defects.

3. Proposed System

The proposed system of automatic PCB verification system through image processing using LABVIEW aims to automate the process of PCB verification by using image processing techniques. The system will use LabVIEW software to process images of the PCB and compare them to a reference image to detect any differences or defects.

The system will consist of a camera or scanner to capture images of the PCB, which will be processed using LabVIEW software. The software will use image processing techniques such as edge detection, thresholding, and pattern recognition to identify any differences between the captured image and the reference image.

The proposed system will be beneficial for PCB manufactures as it will reduce the time and effort required for manual inspection and improve the accuracy and consistency of the inspection process. It will also help to reduce the number of defective PCBs that are produced, leading to cost savings and improved product quality.

4. Methodology

1) *PCB under inspection:* This component represents the physical printed circuit board that needs to be inspected.
2) *Camera:* A camera is used to capture images of the PCB. The camera can be a digital camera or a specialized machine vision camera.
3) *Image Acquisition:* The image Acquisition component of the system is responsible for capturing images of the PCB. This component is typically implemented using LabVIEW's image acquisition functions.
4) *Image Processing:* The image processing component of the system is responsible for analyzing the images captured by the camera and detecting defects on the PCB. This component is typically implemented using LabVIEW's image processing functions.
5) *Defect Detection:* The defect detection component of the system is responsible for identifying defects on the PCB. This component is typically implemented using LabVIEW's graphical programming environment.
6) *User Interface:* The user interface component of the system provides a graphical interface for the user to interact with the system. This component is typically implemented using LabVIEW's graphical programming environment.
7) *Output:* The output component of the system is responsible for displaying the results of the inspection to the user. This component can include visual feedback such as highlighting defects on the PCB, as well as text and numeric feedback to indicate the severity and location defects.

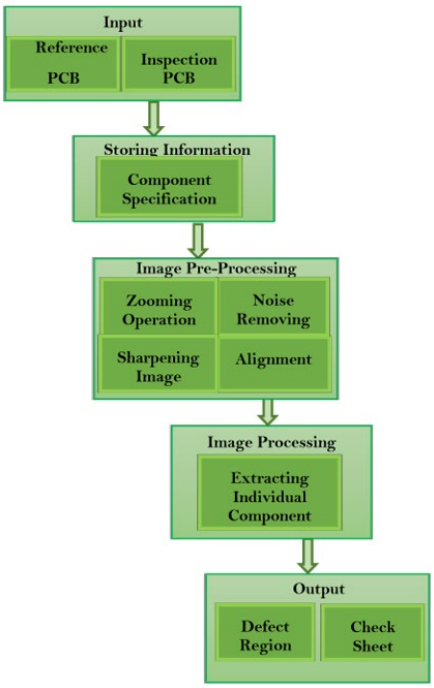

Fig. 1. Block diagram of proposed system

Overall, this block diagram shows how the different components of an automatic PCB inspection system through image processing using LabVIEW work together to detect and identify defects on a printed circuit board.

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 for the output it will be in 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. These values are given to the 'Setup Match Color Pattern' icon is shown in fig. 2.

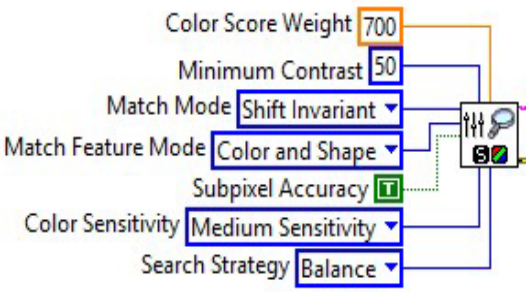

Fig. 2. Setup match color pattern values

The reference and test images are taken and both the images are converted to array values. The color image is converted to the array value, this value is represented in 32 bit for each pixel. From the reference board individual component images are

extracted. To extract the component images position and details are given as input thus, this method is called training, hence it is one of the important stages, further the same method is implemented and the image is converted to array and checked. The component image matrix and reference image matrix is overlapped. For checking individual component bit different the component may be vertical and horizontal to match that image has to be rotated.

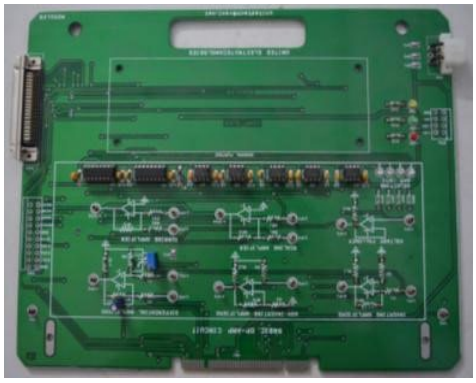

Fig. 3. Image of reference board

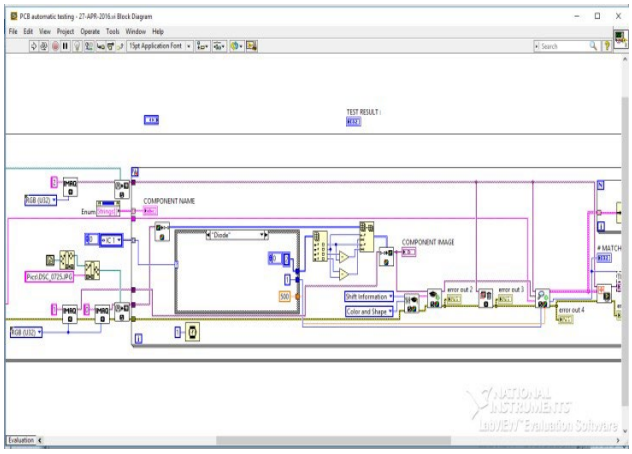

Fig. 4. LabVIEW code

5. Results

The automated PCB inspection is carried out for 16 images. It checks PCB. It is very fast, which displays the component image and the test image as shown in figure. 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, the components position is highlighted with red box in the images. If the position information is required can be extracted separately. The result is tabulated in the table. The table contains number of rows and number of columns, in column it contains the components and, in the rows, it contains the PCB name.

The result can be extracted to word format, which gives the detailed report that if the board is passed or failed, if it is failed, we will get know easily because it displays the defected component in red box. Output of the project is Detection of any missing components; physical dimension of the component is verified and detailed check sheet will be extracted.

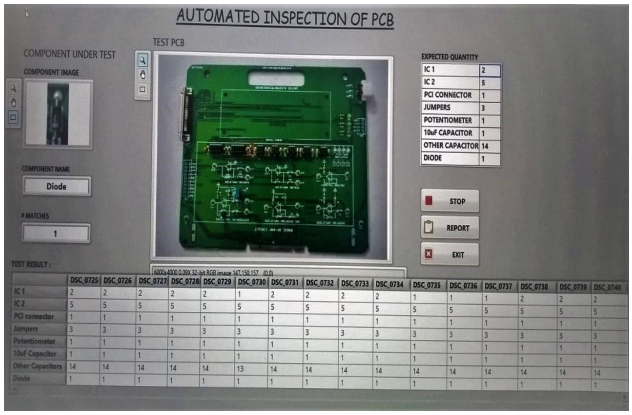

Fig. 5. Automated PCB inspection window

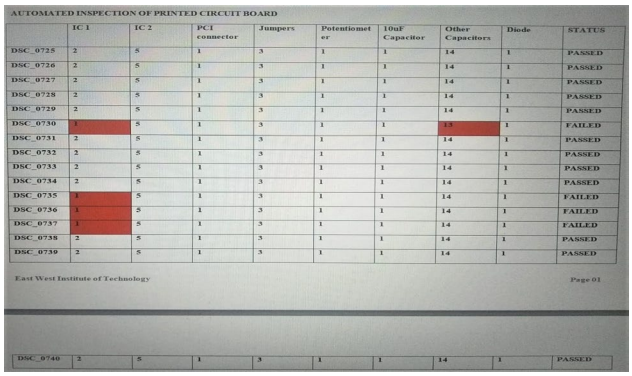

Fig. 6. Detailed report format

6. Conclusion

In this paper, we proposed an automatic fault detection system for assembled PCBs using the LabVIEW software and image processing techniques has provided a faster, more accurate, and cost-effective solution to identify defects and inconsistencies in printed circuit boards. By utilizing image processing techniques, defects and inconsistencies can be easily detected and promptly addressed, ensuring that the PCBs produced meet the established standards for quality and reliability.

With the use of LabVIEW's powerful software, the system is capable of reading, analyzing and comparing images of PCB's, further reducing the chances of human errors and making the process of PCB verification more efficient. Such automation will result in considerable time and cost savings for manufactures and enhance the quality of their products.

Overall, the development of an automated PCB verification system through image processing using LabVIEW has enabled the electronics industry to produce high-quality PCBs more efficiently and accurately, reducing the potential for errors and ensuring that the PCB meets the industry standards.

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