

Error Detection In Printed Circuit Board Assembly

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Abstract—Electronic components make the day to day works easier. Printed Circuit Boards being the important part of any electronic component, helps for its proper working. Minor errors in such PCBs result in complete system failure. Thus an Automated system for PCB Assembly makes technological advances in PCB design and provides an easy way to acknowledge the error in assembled PCBs. A standard set of PCB and certain specifications are set as a prerequisite. The different PCB design images loaded as an input to the generated algorithm. Hence through the Image Processing technique the errors in the PCBs are detected

Keywords—Assembled Printed Circuit Boards, Automation Image subtraction(XOR).

I. INTRODUCTION

The PCB (Printed Circuit Board) manufacturing is becoming more and more important as the consumer electronics products, such as mobile phones, tablet PCs, automatic washing machines and so on, are indispensable for our everyday life. From smart phones to kitchen appliances, electronics play a important role in our daily routine. The heart of each of electronic product is a PCB. Thus leads to the development of Technology. A circuit board prior to assembly of electronic components is known as PCB. Printed circuit board assembly (PCBA) is the process of connecting the electronic components with the wirings of printed circuit boards. Two types of technologies used in assembling of PCB. They are Surface Mount Technology(SMT) and Through Hole Technology(THT). A small error in PCB will contribute to the total failure of a system. Automated Optical Inspection is the technology used to detect the errors in such complicated designs.

1. SURFACE MOUNT TECHNOLOGY

SMT is a method for producing electronic circuits in which the components are mounted or placed directly onto the

surface of PCBs. An electronic device so made is called a surface-mount device (SMD). The various SMD packages are Small Outline Transistors, Small Outline Diodes (SODs), Small Outline ICs, Quad Flat Package, Land Grid Array (LGA), MOSFETs Small Outline J-Lead (SOJ-L), etc. Fig 1 shows the process flow of SMT.

First process involved in SMT is Baking, in this process moisture content in the bare PCB will be removed, then solder paste is applied on to board in Screen printing process and it is inspected by Solder Paste Machine followed by placing SMD on PCB at the appropriate location in Pick and place process, then it is inspected by Automated optical inspection (AOI), then it is passed through Reflow machine to get the components to be soldered again inspected by AOI, if there is any defect sent to rework, if there is no defect, then board is sent for Through hole process.

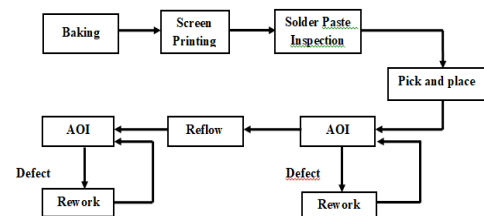


Figure1: Process flow of Surface Mount Technology

2. THROUGH HOLE TECHNOLOGY

Through-Hole technology can also be spelled as “thru-hole”, refers to the mounting scheme used for components that involves the use of leads on the components that are inserted into the holes drilled in the printed circuit boards and soldered to pads on the opposite side either by manual

assembly or by the use of automated insertion mount machines. The various THT packages include axial leads, radial leads, single in line package and dual in line package . The components are capacitors , Resistors, potentiometers, connectors,, diodes, crystal, fuse, inductors, transformers, thermistors, switch, LEDs, jumpers, relay, ICs etc

Fig 2 shows the process flow of THT. Forming is the first process in THT, in which TH components are modified from original shape to the required shape based on the requirement of the PCB, fixing of mechanical parts are performed in hardware fixing process followed by Masking based on the requirement. Stuffing is the process in which formed components are mounted on the board. The overall process held in the TH will be inspected manually and is passed to the wave soldering in order to solder the stuffed components.

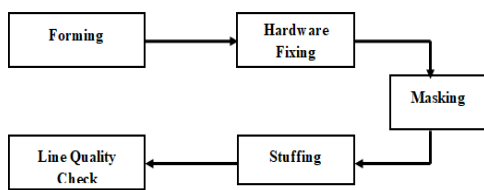


Figure 2: Process flow of Through-Hole Technology

3. AUTOMATED OPTICAL INSPECTION

Automated optical inspection is an automated visual inspection of a PCB manufacture where a camera autonomously scans the device for both catastrophic failure and quality defects. It is commonly used in manufacturing process because it is a non-contact test method. The AOI systems are mainly used after the solder reflow or post production mainly because, post reflow AOI systems can inspect most types of defects at one place in the line with one single system. This way the faults are reworked and other boards are sent to the next process stage. The defect analysis may be either rule based or CAD based in which the board is compared with the intended design. The AOI inspects the defects mainly in two cases:

- SMT inspection
- Bare PCB inspection

III. IMPLEMENTATION OF THE SYSTEM

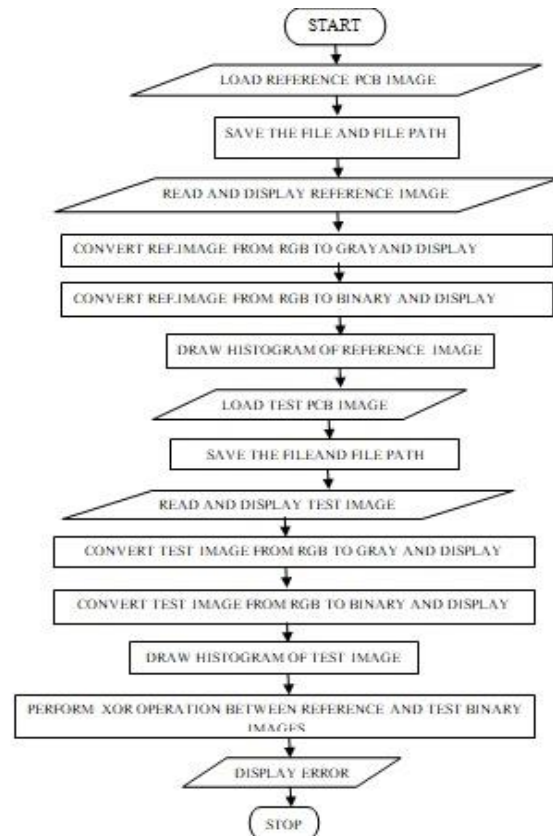


Figure 3.Implementation of System

The process of Detection of errors in Assembled PCBs can be done using MATLAB using the Image Processing Toolbox. This provides the various functions that can be used in order to execute the code. The steps required in executing the code are given here.

STEPS OF EXECUTION

1. Load the image of the Reference PCB in the form of “.jpg”.
2. Save the file and file path in a memory location and provide a name.
3. Read the Reference image and display it along an axis.
4. Convert this Reference RGB image into Gray scale and display it on the axes.
5. Convert the RGB image into binary image in order to classify the different components clearly.
6. Draw the histogram of the Reference image.
7. Load the image of the Test PCB in the form of “.jpg”.
8. Save the file and file path in a memory location and provide a name.
9. Read the Test image and display it along an axis.
10. Convert this Test RGB image into Gray scale and display it on the axes.
11. Convert the RGB image into binary image in order to classify the different components clearly.
12. Draw the histogram of the Test image.
13. Perform XOR operation for the binary Reference image and the Binary test image.

14. Display the difference image. This image refers to the errors with respect to the Reference and the test PCB images.

II. SOFTWARE REQUIREMENTS

The software used in implementation of the code is MATLAB. Makers of MATLAB are the MathWorks. This tool is very useful in providing solutions to many real time problems. This is used for various applications of Image Processing, Speech Processing, Deep Learning, IoT, Motors etc. MATLAB has various inbuilt functions for any particular application that helps reducing the code complexity and create more complex functionalities.

Image Processing Toolbox provides a comprehensive set of reference-standard algorithms and workflow apps for image processing, analysis, visualization, and algorithm development. One can perform image segmentation, image enhancement, noise reduction, geometric transformations, image registration, and 3D image processing.

Image Enhancement :-The process helps in retrieving the original image and increasing the quality of the image. Contrast stretching is one of the major function in image enhancement. This process improves the contrast by stretching the range of intensity values or pixel values. This process is also referred as Normalization.

Pre-processing for Colour:-This process helps obtain the image components with respect to different planes and by combining best part of all the planes to get enhanced picture.

Conversion of RGB to Gray images:-For images to be processed, it must be converted from RGB to Gray scale.

Binary Conversion:-The RGB image should be converted to Binary image by setting a proper threshold value between 0 and 1.

MATLAB for Graphics and Graphical user interface Programming:-MATLAB supports developing applications with Graphical user interface(GUI) features. MATLAB uses GUIDE that is GUI development Environment for graphically designing GUIs. It also has tightly integrated graph plotting features in it.

Regionprops:-This helps extraction of details like area of object, convex area, centroid, major axis length, minor axis length, perimeter, orientation, solidity, pixel list and pixelidlist.

IV. RESULTS AND DISCUSSIONS

The algorithm written hence helps to display the Reference image and the Test image in the form of RGB, Gray and Binary scale. The Binary images are XORed and the resultant output finding the errors with respect to the missing components is determined.

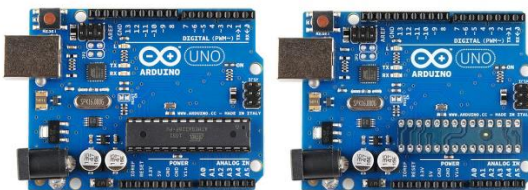


Fig4a:Reference Board Fig4b: Test Board

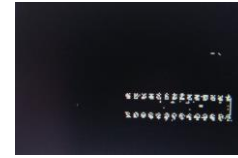


Fig4c:Defect Identified

Figure 4.Experimental output

V. CONCLUSION

It is 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.

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.

VI. FUTURE ENHANCEMENT

The error detection methodologies in Printed circuit boards have been proposed in this system. Further the code can be enhanced to increase the efficiency of the entire system and make the system work with the Printed circuit board images that can be taken in different environments.

APPLICATIONS

- Small scale electronic manufacturing industries
- In Educational Institutes

ACKNOWLEDGMENT

The satisfaction that accompanies the successful completion of a task would be incomplete without the mention of the people who are involved in it. We wish to express our sincere and heartfelt gratitude to those who guided us to accomplish the assigned Project. We feel immense pleasure in expressing our deep sense of profound gratitude to our beloved Chairman & MLA Chamaraja Constituency, Mysuru **Sri Vasu** and our beloved Secretary, VVET@ Sri **Kaveesh Gowda V** for their encouragement and support in all our Endeavors. Our sincere thanks to **Dr. M Ravishankar**, Principal, VidyaVikas Institute of Engineering and Technology, Mysuru for the continual encouragement throughout the Engineering Course. Our heartfelt gratitude to **Dr. Bindu A Thomas**, Professor and Head, Department of Electronics and Communication, VidyaVikas Institute of Engineering and Technology, Mysuru for valuable suggestions at all stages of our Course. We extend our most profound gratitude, immense pleasure and heartfelt thanks to our esteemed Project guide **Mrs. Anitha D B**, Associate Professor, Department of Electronics and Communication Engineering for the valuable supports in the completion of our project assignment into productive and fruitful one. Our Sincere regards to all Project Coordinators for their active interaction and contributions at every stage of execution of the assignment. Our heartfelt gratitude to our parents, to have

withstood all our troubles and tantrums throughout the project duration, A special thanks to all our dear friends for their active encouragement, finally all our classmates for their active interaction and contributions at every stage of execution of the assignment.

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