PCB Defect Detection Using Image Processing And Embedded System

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Abstract –*This project is motivated mainly by the need for more efficient techniques in inspection of the PCB in fabrication process. The objectives of this project are to provide an inexpensive and comprehensive defect detection technique. Introducing and implementing a PCB inspection system using image processing to remove the subjective aspects of manual inspection. At the same time, this system provides real time assessment of the PCB. The basic technique of the proposed system is to detect the defect based on the digital image of the PCB using image processing techniques. There are a few steps to detect defect of bare PCB. First of all, the system should collect PCB images through camera. After special image recognition and analysis process, the images should be compared with the templates, thus the common defects such as short circuit, open circuit, shorts, missing holes and other defects can be found out precisely. To get the details about the defects, extracting the structural features based on the regional properties such as perimeter, regional areas, orientation etc. Finally the recognition results will be acquired and reported. Under the control of the Controller, the PCB delivering components like conveyor belt, DC motor automatically move the given PCBs. Image acquisition and moving control subsystem receives the central computer's control commands, acquires the PCB images real-timely and processes them using MATLAB. The result data will be sent to the central computer and displayed on GUI*
Key Words: Camera, DC Motor, Switches, RS232, Computer, PIC Microcontroller, Conveyor System.

1. INTRODUCTION

A bare printed circuit board (PCB) is a PCB that is used before the placement of components and the soldering process. It is used along with other components to produce electronic goods. During the manufacturing of printed circuit boards, widths of insulators and conductors can change because of manufacturing defects such as dust, over etching, under etching, and spurious metals. Etching is the process, where the copper board will undergo „peeling" process, where the circuit layout will be preserved while the rest of the copper background will be washed out. In order to minimize scrap caused by the wrongly etched PCB panel, inspection has to be done in early stage. To reduce manufacturing costs associated with defected bare PCBs, the inspection of bare PCBs is required as the foremost step of the manufacturing process. This project is motivated mainly

by the need for more efficient techniques in inspection of the PCB panel in PCB fabrication process. Normally, a couple of operators are assigned in each station to manually check the PCB panels. This technique is not economical in a long run as it takes many man hours. In addition, humans are prone to making errors especially due to fatigue. Moreover, it is impossible to check the entire PCB panels at every location without any delay. Instead, the printed laminate is sampled a certain interval of quantity for manual inspection. As the electronic circuitry technology advances, the PCB pattern becomes denser and complicated to facilitate smaller end products. Thus, manual inspection is not applicable anymore. Meanwhile, the advances in computers in term of high speed, large memory with low cost have resulted in better and cheaper equipment for image processing. Hence, there exist a possibility of introducing and implementing an automated PCB inspection system to remove the subjective aspects of manual inspection. At the same time, the automated PCB inspection system provides real time assessment of the PCB panel.

PCB defects can be categorized into two groups: Functional defects and cosmetic defects. Performance of the PCB gets affected by the functional defects. Cosmetic defects affect the appearance of the PCB, but can also jeopardize its performance in the long run due to abnormal heat dissipation and distribution of current [1]. However, in a long period, the PCB will not perform well since the improper shape of the PCB circuit pattern could contribute to potential defects. Thus, it is crucial to detect these two types of defects in the inspection phase. Figure 1(B) shows an artificial defect-free PCB image pattern [2]. Figure 1 (A) shows the same image pattern as in Figure 1 (B) with a variety of defects on it. The printing defects and anomalies that will be looked at, for example, are breakout, short, pin hole, wrong size hole, open circuit, conductor too close, under etch, spurious copper, mouse bite, excessive short, missing conductor, missing hole, spur and over etch. These defects are shown in Figure 1 (A).

 1.breakouts 2.Pin hole 3.open circuit 4.under etch 5.mouse bite 6.missing conductor 7.spur 8.short 9.wrong side hole 10.conductors too close 11.spurious copper 12.excessive short 13.missing hole 14.overetch
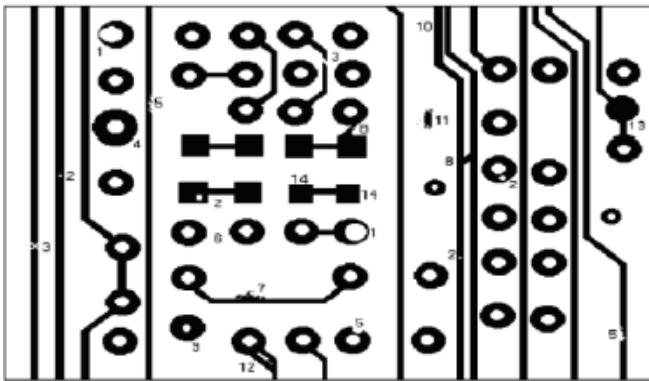
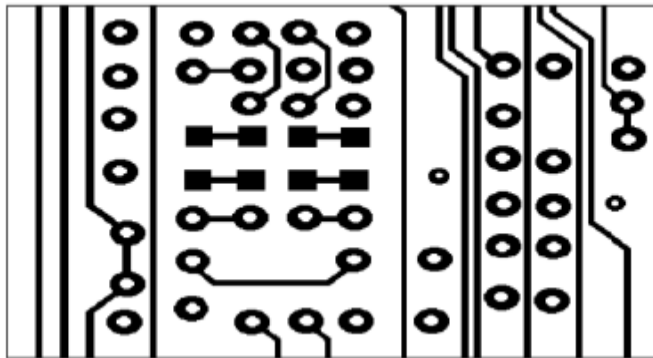**Figure 1 (A): An Example of Defective PCB Patterns**

Figure 1 (B): An Example of Good PCB Patterns

2.PROBLEM DEFINITION

Production of the printed circuit board (PCB) is one of the important key components in the most of the electronics industries. The latest existing technology is advanced to full digital implementation, it is envisioned that the manufacturing of PCB will ever growing. It is very important to produce the PCB with zero-defects. This is to ensure a high quality PCB that translates to reliable and quality digital end products. Initially, the bare PCBs (PCB without components attached to it) were inspected randomly using manual inspection system, which involves human operators. This technique is quite costly since it is highly error-prone due to human error. A more sophisticated way of doing the inspection is the use of in-house circuit testing (ICT) technique.

This technique uses a very expensive machine that checks the conductivity of the PCB using probes. However, the limitation of this technique is it can only detect defects that are based on either shorts or open. So it is essential to provide an alternative inexpensive and comprehensive defect detection technique. The basic technique of the proposed technique is to detect the defect based on the digital image of the PCB using image processing techniques. The objective of this project thus is to provide an alternative inexpensive and Comprehensive defect detection technique.

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3. LITERATURE SURVEY

3.1 **Research Methodology:** Based on the literature, the detection and classification of defects are the most significant considerations in the configuration and improvement of a programmed PCB assessment framework. Thus, the major tasks involved in developing the AIS-PCB for the classification of flux defects are the following:

 (1) Image Acquisition and Segmentation (IAS)

 (2) Indexing Features (IF)

 (3) Flux Defect Classification (FDC)

Combined with examination and evaluation. Several inspection operations are applied in each task, as indicated in Fig. 1, which represents a detailed scheme for the proposed AIS-PCB system in this research. PCB Image Database.

This research represents an effort to develop a new automatic inspection system for PCBs. The proposed AIS-PCB is capable of classifying PCB flux defects and therefore of ensuring high PCB manufacturing quality. The segmentation approach provides an index guide for flux defects, which act as powerful tools for flux defect extraction. RT successfully extracts features from PCB images and gain feature vector description, which can be used for classification. The study shows the feasibility and capability of using MLP algorithmic models for PCB classification, among which the proposed approach attains the highest classification performance with less computational complexity. Based on the performance results, the Radom feature vector descriptors and MLP model classification are validated and proven to be a robust mechanism for the classification and recognition of flux defects in the data set of PCB images. The real-time AIS-PCB machine vision system is capable of sorting PCB flux defects based on texture with machine vision processing. The AIS-PCB system is developed based on various image-processing techniques using imaging software to classify the PCB flux defects as either accepted or rejected.
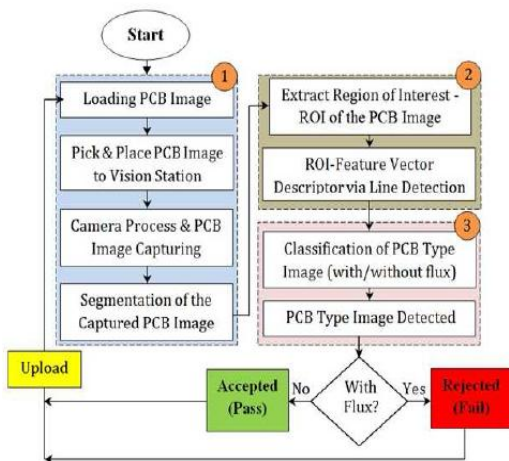
Figure 2: Inspection of flow part

3.2 IMPLEMENTATION OF METHOD:-To implement the image subtraction logic some software tools are required. There are various tools available for implementation. Here NI Vision Assistant is being used as a development tool.

A. Vision Assistant 2009**:**

Vision Assistant is a tool for prototyping and testing image processing applications. Build custom algorithms with the Vision Assistant scripting feature [9] are used to prototype an image processing application. After completing the algorithm, we can test it on other images to make sure it works. The algorithm is recorded in a Builder file, which is an ASCII text file that lists the processing functions and relevant parameters for an algorithm that we prototype in Vision Assistant.

B. Inspection flow chart**:**

The PCB inspection using Image subtraction method [7], [10], [11] is performed in steps. As shown in flow chart (fig. 3) the first step load a reference image, second step buffers the reference image so that it can be used for subtraction operation. The third step loads the image which is going to be inspected. To find the PCB error, inspected image is XORed with reference image; this process is also called Image subtraction.

C. Image Subtraction Operation**:**

Image subtraction operation is performed in order to get the differences between two images [3], [4]. The images are the reference image and the inspected image. The method compares both images pixel-by-pixel using XOR logic operator [7], [9], [12].The subtraction operation will produce either negative or positive image, '1' represents white pixel and '0' represents black pixel in a binary image.

Two rules exists for image subtraction operation

Rule 1: If 1-0 = 1 then it gives positive pixel image

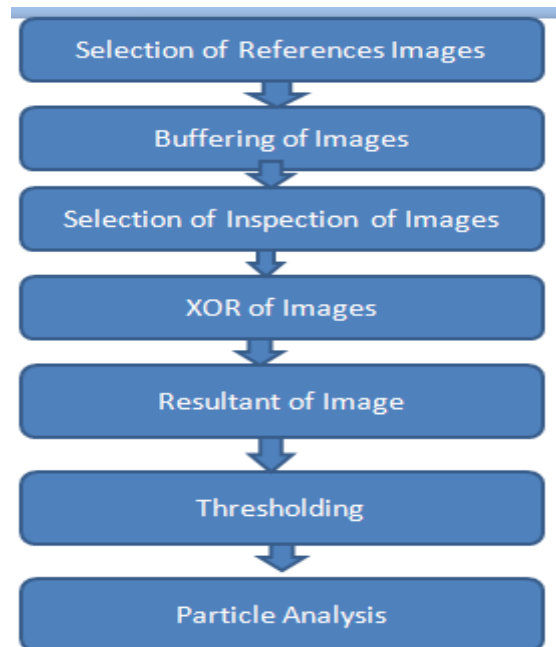Rule 2: If 0-1 = -1 then it gives negative pixel image

Figure 3: Inspection of flow part

D. Logic and Comparison Operators:

Logic operators are bitwise operators listed in Table I. They manipulate gray-level values coded on one byte at the bit level [9]. In the case of images with 8-bit resolution, logic operators are mainly designed to combine gray-level images with mask images composed of pixels equal to 0 or 255 (in binary format 0 is represented as 00000000, and 255 is represented as 11111111), or to combine or compare images with a binary or labelled content (after thresholding the image).

LOGICAL OPERATORS

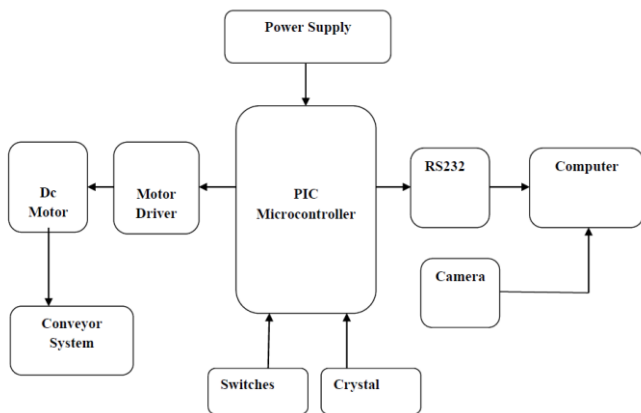| Logical Operators	Operator Equation
AND	pn = pa AND pb
NAND	pn = pa NAND pb
OR	pn = pa OR pb
NOR	pn = pa NOR pb
XOR	pn = pa XOR pb
Logic Difference	pn = pa AND (NOT pb)

3. PROPOSED SYSTEM
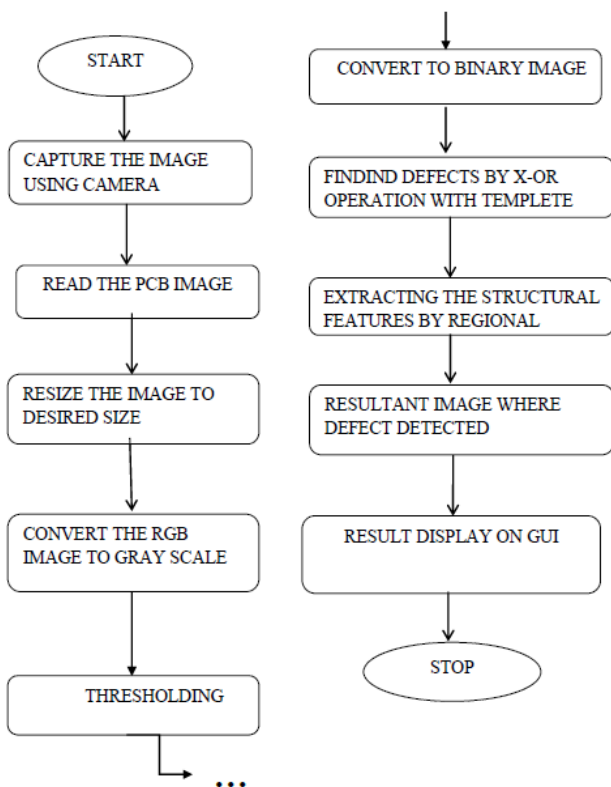

Figure 4: Block diagram

4. FLOWCHART

Figure 5: Flowchart

6. RESULTS AND DISCUSSIONS

In this system, we are displaying results on GUI because in this user can load the image, starts the processing on it by selecting given graphical elements for it .So t is well known that GUI is very easy to use as it does not need more experience or training to use.

Following images shows final output displayed on GUI. We have developed our model on a real time system and its result is getting displayed on GUI. Experimental result shows that the test image is grabbed and processed by the proposed algorithm within 15 second.
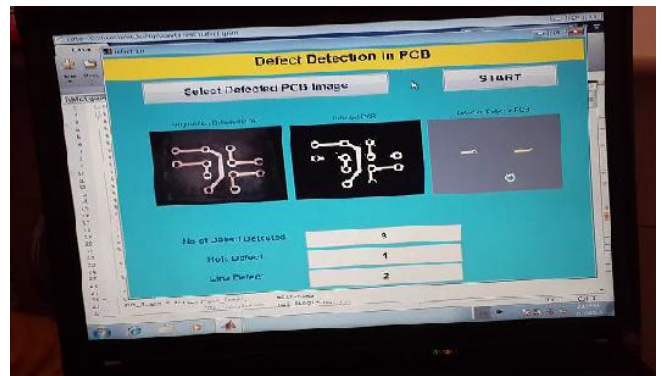

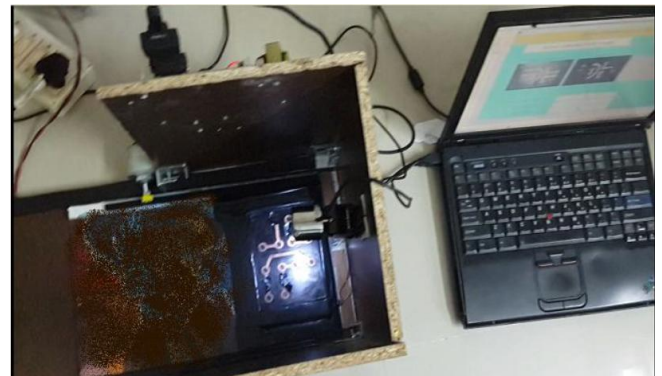Figure 6. Result image showing two line and one hole defects.

Figure 7. experimental setup of the system

7. CONCLUSIONS

This research studies automated PCB inspection system for detecting defects on bare printed circuit board. In the process of implementing the system, we found out that careful plans are required in each steps such as image acquisition, image processing, image edge extraction and defect recognition. At present, the finished designed system can detect common PCB defects such as: missing hole, open circuit etc. After images have been captured image subtraction operation, minimum thresholding and noise removal operations are used to get noise-free positive and negative images. Then structural features have extracted using regional properties to get the detail information of the defects. Even though, this system is not being able to receive GPS signals in indoor regions and also delays in responding because of GPS. Since GPS delays in receiving data from satellite side.

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BIOGRAPHIES

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