A Review of The PCB Defect Detection Using Image Processing

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Abstract- *The importance of the Printed Circuit Board inspection process has been magnified by requirements of the modern manufacturing environment. In electronics mass production manufacturing facilities, an attempt is often to achieve 100% quality assurance. In this work Machine Vision PCB Inspection System is applied at the first step of manufacturing. In this system, a PCB inspection system is proposed and the inspection algorithm mainly focuses on the defect detection and defect classification of the defects. Defect classification is essential to the identification of the defect sources. The purpose of the system is to provide the automatic defect detection of PCB and relieve the human inspectors from the tedious task of finding the defects in PCB which may lead to electric failure.*

Keywords- Automated visual Inspection system, Image subtraction, Thresholding, segmentation.

I. INTRODUCTION

Now-a-days human vision inspection process is necessary to improve for quality of PCB. In manufacturing industry there are defects, misalignment, and orientation error so automated inspection is required. The defects can be analyzed by software using algorithms developed for it. These systems have advantage over human inspection in which subjectivity, fatigue, slowness and high cost is involved. In recent years, the PCB industries require automation due to many reasons. The most important one is the technological advances in PCB's design and manufacturing. New electronic component fabrication technologies require efficient PCB design and inspection method with compact dimension. The complex and compact design causes difficulties to human inspection process. Another important factor is necessity to reduce the inspection duration. These factors lead to automation in PCB industry. Nowadays automated systems are preferred in manufacturing industry for higher productivity.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

1) 'PCB defect Detection and classification Using Image Processing' by Kaur Kamalpreet, 2014
2) "Digital Image Processing" by Gonzalez
3) http://www.electroschematics.com/10482/pcb-defects-detection-opencv/

III. WRITE DOWN YOUR STUDIES AND FINDINGS

A. Bits and Pieces together

From the research of some papers, it is clear that there are different methods for detecting segments from the image. Hough Transform can be used for line detection; different 2D masks can be used for edge detection. Hough transform can also be used for circle detection.

In this research, edge detection is done by using Prewitt mask. Horizontal and vertical gradients are able to detect the edges in vertical and horizontal direction respectively. After detecting the edges, there is further need to develop an algorithm for detecting circles, thick and thin lines separately as well as squares.

B. Use of Simulation software

In MATLAB software image processing operation can be easily performed and results are very effective. In MATLAB due to C language program becomes simple and easy to understand. Image processing toolbox is inbuilt in MATLAB software, so it is very useful to operate it.

IV. GET PEER REVIEWED

The proposed algorithm in paper [1] involves MATLAB image processing operations such as, image subtraction, image difference, complement, flood fill, image addition. Image subtraction means a new image is obtained as a result of the difference between the pixels in the same location of the two input images being subtracted. In Image difference operation a new image is obtained as a result of comparison of both images pixel-by-pixel by XOR logic operator. Complement operator is normally used to change the image from black to white and vice-versa. Flood fill operator changes the color of a region. In grayscale images the holes are filled. Image addition is a method of combining

objects in two images. The study follows a two step process to detect and classify the defects. For detection of defects the template image from fig.1 and the defective image from fig.2 are compared using image subtraction operation to obtain positive image (Ip), shown in fig.4 and negative image (In) shown in fig.3 i.e. In=It-Id and Ip=Id-It .The addition of positive and negative image gives all the defects present in defective image i.e. Ia=In+Ip as shown in fig.5. In second step classification of defects is done. Here the defects have been classified and grouped into 5 groups : (1)wrong size hole and missing hole (2)spur, short, conductor too close, under-etch, spurious copper and excessive short (3)pinhole and breakout (4)over-etch, mouse-bite and open circuit (5)missing conductor.

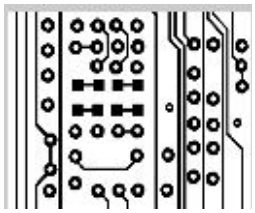

Fig.1.Template image (It)

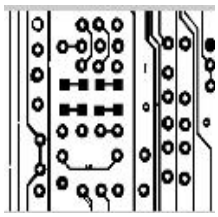

Fig.2.Defective image (Id)

Fig.3. Negative image (In)

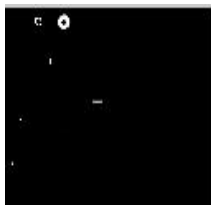

Fig.4. Positive image (Ip)

Fig.5. detected defects (Ia)

The technique proposed in paper [2], basically focuses on the detection of defects in the PCB. The RGB colored image is first converted into grayscale image. Then the image is subjected to image subtraction operation which obtains the difference between the test image and reference image. This is done by using logical operators. An arithmetic or logic operation between images is a pixel by pixel transformation. It produces an image in which each pixel derives its value from the value of pixels with the same coordinates in other images. If A and B are the images with a resolution XY, and Op is the operator as shown in fig.6, then the image N resulting from the combination of A and B through the operator Op is such that each pixel P of the resulting image N is assigned the value pn = (pa)(Op)(pb) ; where pa is the value of pixel P in image A, and pb is the value of pixel P in image B.

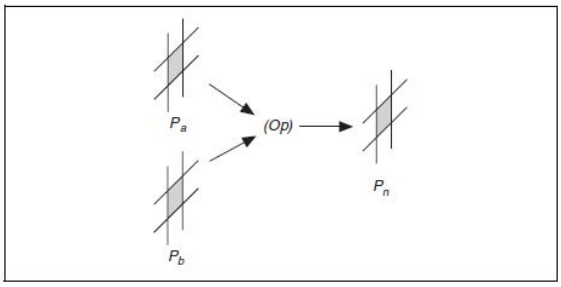

Fig.6. Operator Concept

Here XOR logic operator is used. This difference can be positive or negative. Positive image is the result of subtracting test image from the reference image while negative image is the result of subtracting the reference image from the test image. The combination f positive and negative image resulted will give the defects in the image. This defected image is then converted into binary image by using Thresholding. The particle analysis is applied on the obtained defected area of PCB using NI Vision Assistant and outputs are represented in terms of parameters such as area, orientation, X and Y coordinate etc. Here pixel is being used as a unit for measurement.

In paper [3], mathematical morphology is used for image segmentation. The algorithm is to segment the image into basic primitive patterns, enclosing primitive patterns; pattern assignment, pattern normalization and classification have been developed based on binary morphological image processing. After performing segmentation by mathematical morphology they enclose each pattern so that only pixels under this window will be processed for defect detection they perform image subtraction operation the next step is assignment operation which define the position of the enclosed defect patterns relative to the enclosed test image patterns. Image segmentation is carried out. After image segmented the thresholding is done by converting grayscale image into binary. The binary images are fed into the image processing algorithm and it is done using image difference operation. After that image subtraction is done and lastly image addition process is carried out. Image addition is a method for combining objects in two images into one image.

In paper [4], Authors proposed real time PCB defect detection system. The algorithm is as shown in fig.7. The stages involved in this system are image acquisition, image registration, defect detection, thresholding, and filtering and defect classification. For image acquisition, real PCB images

are captured using charge couple device (CCD) camera. To take entire PCB image they set maximum distance between the CCD camera & inspected PCB is 34 cm. A PC2-vision frame grabber has been used to digitize & store the images into computer. Next defective image is registered by software according to the template image. Next stage is image subtraction. In that pixel in the template image and defected image are subtracted from each other.

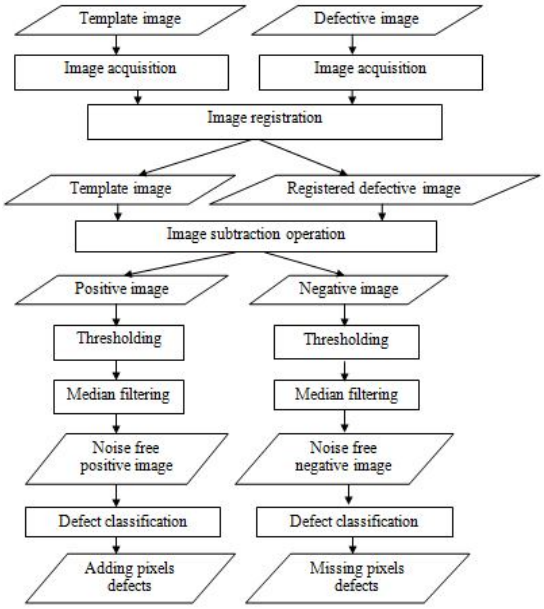

Fig.7.Flowchart

The output images produced are positive image and negative image. To convert resultant image into binary image thresholding operation will be performed. Thresholding operation is depending on the threshold value. If the pixels in the image are greater than the threshold value then they converted to white. If the pixels in the image are less than the threshold value then they converted to black. In this paper, for positive image and negative image author select threshold value 165 and 157. As the image is captured in real time there will be noise present in the image. To remove small noise in the both threshold images median filtering operation is performed. For defect classification they use several image arithmetic and morphological operations. The defect can be classified as per the pixels in the image are added and missing. They classify six defects which are pin hole, missing holes, short circuited defects, under-etch, open circuit, mouse-bite defects. The computation time for this system is very few seconds which vey less as compared to manual inspection. The system described in this paper is cheap as mechanical alignment facility is no need to purchase.

V. CONLUSION

The detection and classification results of proposed methods are promising. Most of the defects like wrong size hole, missing hole, missing conductor, pinhole are successfully detected without any misclassification. The proposed method has some drawbacks like it requires same size of real and defective images and it requires orientation of test image and base image.

VI. ACKNOWLEDGEMENT

It gives me an immense pleasure to present the paper here. It has been quite experience, facing a number of problems at stages and coming up with appropriate solutions, at time the discussion amongst us or suggestions from our friends and teachers.

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