

Fault Detection of Any PCB Using Image Matching Algorithm

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Abstract— This system is designed for the detection of incorrect electronic components on the printed circuit board (PCB). The aim of this system is to manufacture the electronic devices quickly without any faults in the printed circuit board. The mounting the electronics component on the PCB is a very critical work which makes many mistakes like an open circuit, short circuit, circuit breaks this type of problems are overcome by using this system. This system can identify the incorrect position of electronics components on the circuit board by using image matching algorithm. This system able to identify only having reliable text on the components, if their no text present on the component, then this system does not work. For edge detection purpose Canny Edge Detection Using PCA algorithm is used. Different types of factors like the angle of PCB, Ununiformed light condition, the distance between the PCB and the camera etc. are very important during processing an image. Various factors are considered during processing an image like tilting angle of PCB, position of camera, light condition, and the fix distance between camera and the PCB. In this system every time reference PCB is compared with test PCB if the position of components in PCB is incorrect, then it will show by the only red circle in MATLAB.

Keyword—MATLAB, PCB, Image Processing, Camera, PC, etc

I. INTRODUCTION

The printed circuit board is only a copper plate on which the electronics components are mounted and form a device. This device is made up of various types of components like a surface mount device component and directly placed components. After mounting the electronics components on the printed circuit board one device is formed and that device can be used in any electronic equipment. There is various steps are needs to follow to make one single PCB such as cleaning, etching, drilling etc. And on another side one problem is created during an manufacturing of PCB in any electronic industry like wrong of component design, incorrect position of components on the circuit board, overheating, gives an higher power supply etc.

Basically the various types of electronics components are get communicate with each other with the help of soldering them with each other. On one single PCB all component are get communicate with each other. To find the faults in printed circuits board various technique are used. In this technique the correct printed circuit board which is called as reference image is taken and this PCB image is compared with the newly manufacturing PCB image. By applying various techniques on this image easily find the fault in printed circuit board.

In the given system firstly need to design suitable windows standalone application by using MATLAB. And this application is installed in any windows machine. By running

the given application user can operate this system. The given system is used to find the incorrect orientation of components, only capacitors and integrated circuits etc. This system gives results only on when the components are gets labelled and encircled. The result of this system is show in MATLAB. First needs to store the database of this component in machine. For every new type of PCB user needs to store new database in a machine, but for same type of PCB user does not need to store database again and again into the machine. By using few steps of setting in MATLAB the system can test printed circuit board in less time. By using one time storing the database in machine of the same kind of PCB it saves a lot of times and it can increase the speed of manufacturing printed circuit board. To use this system it is needs to place the printed circuit board on the plane surface and the camera is holds above this printed circuit board with some fixed distance. During this process it is very important to place the camera at fixed position and continuous light source is falls on the printed circuit board to capture accurate image of the PCB. After taking the image of the printed circuit board various process are done on this image like noise removal, find angle of tilt of PCB, edge detection, image cropping, thresholding and image matching with the reference printed circuit board image. By applying this process on the new tested image the result can be obtained. For this purpose user have needs to save the reference image on the PC.

Bin Zhang, Pin Feng, Jiayu Chen and Xianming Deng, the automatic PCB inspection optically. In this technique they use PIC microcontroller for controlling purpose. The PID controller is used for giving the motion to a PCB device. The Kalman filter is used for removing the noise from a captured image. The PLC, which can be used in this system, will control the array camera. On the channel the PCB is moves this PCB image is captured by the array camera. The position of camera and the PCB motion device are arranged in proper way for getting good quality of image. For finding the position component on the PCB PID controller of the Kalman filter is used. The area array camera captured the large area of an image. [1]

D.B. Anitha and Mahesh Rao here the comparison of different papers of double layer PCB and single layer PCB with image processing and Wavelet transform. [2]

S.H Indera Putera, Z. Ibrahim, in this paper they use the mathematical morphology and image processing techniques for finding the fault in PCB. The morphological technique applied on the test and template image for segmenting the image into a number of parts. For enclosing the segmented parts windowing technique is applied on test image for detecting fault in PCB. They segment the test and template image into square, hole, thick-line and thin line form. Not and X-OR operation applied on the test and template image for getting positive and negative image. By applying not an operation on test and template image it inverts the image into binary form. For subtraction purpose X-OR operation is used. The positive image is gets by subtracting test image from the reference image and by subtracting reference image from the test image gets negative image. [3]

Prachi P. Londe, and S. A. Chavan, in this technique machine vision inspection algorithm is used for finding fault in PCB. The morphological segmentation technique applied on standard PCB image and PCB image. For finding the difference between two images the image difference algorithm is used, while KNN classification algorithm is applied on the two images for classification of standard PCB image and PCB image. [4]

Namita Kalyan Shinde, Prof. S. S. Morade presents the work. In this system they use PIC controller for controlling purpose. For comparison of two PCB image the image difference methods are used with, pixel to pixel matching by using X-OR logic operator. The complement operation is used for inverting the binary image. Depending upon regional properties they extract the structural features of the system. [5]

Fabiana R. Leta, Flávio F. Feliciano, Flavius P. R. Martins detect the fatal, potential errors in PCB by the use of computer vision technique. It consists of two images module, first is standard PCB images, module and the second is a test image module. This system checks the errors in PCB likes missing tracks, short circuits, missing holes,

opens and breaks. The database of standard PCB image is already stored in this system. After that the PCB image which is standard is compared with the test PCB image. The system has to need to adjust the light in proper condition and the PCB images taken in same category. If the image contain the fatal errors then the connection analysis methods is applied on each segmented part of an image. [6].

II. BLOCK DIAGRAM

Figure 1 show the block diagram of the proposed system. In this system first need to save the database of reference printed circuit board image in the MATLAB. Take reference image with correct mounting component. After saving the reference image on the desktop of the PC take another printed circuit board with incorrect mounting component which has used to test is save into on desktop of the PC. After that process the test PCB image is resized into an approximate size, by applying image resize technique on the test PCB image. To improve the contrast of the test PCB image histogram equalization technique is used. It increases the contrast of the test PCB image. It enhances the image by adding important information in the form of pixel in the image and it can compress the image by removing the unnecessary information in the form of pixel from an image. It increases the contrast of image by enhancing the intensity range of the image. The noise can be introduced into a test image while taking the picture of the image this noise can be removed from a test image by applying Gaussian filter on the test PCB image.

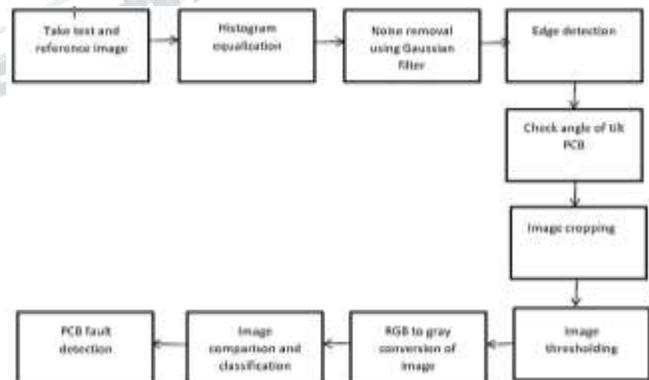


Figure1: Block diagram of the system

To detect the edges of the components which can be mounted on the printed circuit board for that purpose canny edge detection algorithm with principal component analysis is applied on the test image. When image is captured by an camera at that time the image is gets tilted at some angle then an then only image tilt operation are applied on the test image if there is no position of the PCB is change then next step is applied on the test image. The outer unwanted area of

the printed circuit board is remove or cropped by applying image cropping method on the test PCB image. Image thresholding method can be used to convert the grayscale image or color image into binary format. This kind of method is used to draw the boundary line between the two sets of data to represent one complete image. It is very important to convert the color image or gray image into the binary form before applying the canny edge detection method, Because of binary image contains only 1 and 0 value which is very helpful to us to find the desired portion which will be user want. For taking the result the reference image is matched with test PCB image, before this steps user need to convert the binary image into grayscale image which contains all image in gray shades without containing any other color. After that every pixel, shapes, and color of the test PCB is compared with the reference image and finally the result are shown in the MATLAB.

III. PROPOSED SYSTEM

Figure 2 show flowchart of the proposed system. In this system the simple fault detection method is used to detect the fault in the given printed circuit board. The image matching algorithm is used in this system to match the every components image of the test Printed circuit board with the every component image of the reference PCB. The above flowcharts are explained steps by steps as follow. First take reference PCB image and save on desktop as well as all database related to this PCB components are stored in MATLAB. After that take the test PCB image which contain any fault in PCB and this image stored on desktop of the computer. Then apply image histogram equalization on the test image to improve the contrast of image. This technique can only enhance the image without losing any information in the original image. After that Gaussian filter is apply on the test image to remove the unwanted noise which can be added in an image while taking a photo of the PCB. This type of filter simply enhance the image by adding new important information in image and compress the image by removing the unnecessary information is in the pixel format from an image. To detect the edges of the components which can be mounted on the PCB is detected by applying canny edge detection on image. The unwanted outer area are remaining in image is cropped by applying image cropping method on the test image. After that step for getting two fixed value image thresholding technique is applied on the test image. And this image is gets converted into grayscale image from a binary image. After that all this process ones the edges of the component are detected then this image is matched with the reference image which can be stored on desktop of the PC. Once the fault is detected by matching edges of the test PCB image with the reference PCB image then the faults which can be occurred in the PCB is shown in MATLAB.

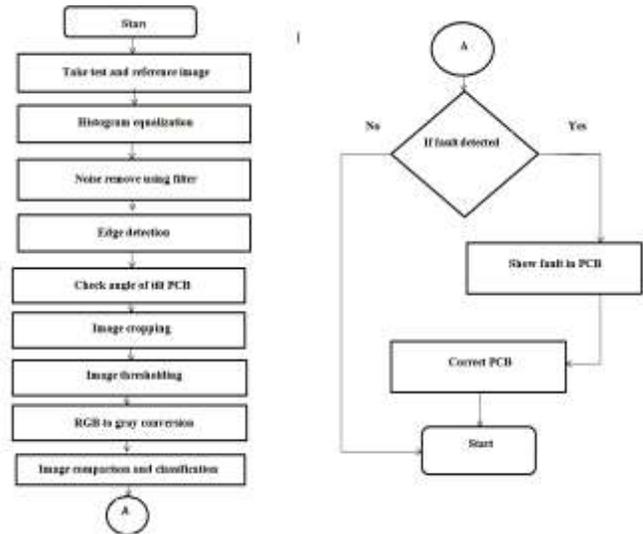


Figure.2: Flowchart of the system

IV. RESULTS AND DISCUSSION

This section describes results obtained by experimentation. In this system first take the printed circuit board which contains electronic components with correct position. Every time new test PCBs matched with the reference PCB to find the fault in PCB. After that test PCB image is saved on the desktop of the PC. Then apply canny edge detection algorithm on the test image. It is very important to compare every time test PCB with the reference PCB. The fault of components is detected on the basis of color, shape, and pixel of every component is matching with each other. After that process the position of the electronic components is incorrect then it will indicate only by the red circle. The incorrect position of integrated circuit is finding based on the notch which is present on the IC. The match parts of all the components are indicated by plus sign inside the red circle. And unmatched parts are indicated by only red circle. To capture image of PCB proper light intensity and fix camera position is needed. If the position of camera and the light is not in proper or fixed position then shadow will be present in captured image. The camera is change with some disturbance then the blurring effect is introduced in image.

4.1 Reference Image

Figure 3 shows a correct reference PCB image. This PCB image is taken as the input image for finding the fault in test PCB by matching the parameters like shape, color and pixel of every electronic component this image.



Figure 3: Correct reference PCB Image

3.2 Test Image

Figure 4 shows a test PCB image. This test PCB image is matched with reference image for finding fault in PCB. Before test PCB is match with reference PCB image various steps can be carried out which can be given in flowchart of the proposed system.



Figure 4: Test PCB Image

3.3 Result of Canny Edge detection algorithm

Figure 5 shows the result after applying the canny edge detection algorithm. Before applying the canny edge detection algorithm the image is converted into binary form and after applying the canny edge detection algorithm to test image it has again converted into a grayscale image. This is very important to convert the color image into binary for finding the portion in the image for further processing. Binary image consists only two values 0 or 1, hence we look clearly at the interested parts. After applying the canny edge detection algorithm to test image it has again converted into a grayscale image. Grayscale image has only gray shades hence, comparing the test image with the reference image needs less information.

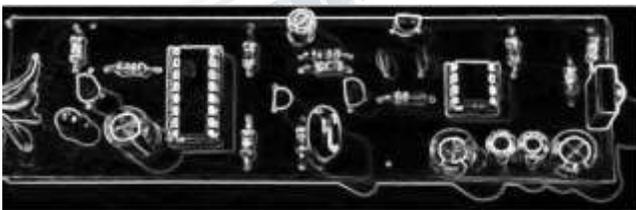


Figure 5: Result of Canny Edge detection algorithm

3.4 Final Image comparison output

Figure 6 shows the final image comparison output of PCB after comparing the reference image and test image of the PCB. On this PCB two component positions are incorrect hence it does not match with the reference PCB image. The

fig.6 shows the fault of the component by the only red circle. Figure 7 shows the inverted image of the final image comparison method. To see clearly result at the output side the final fault detected image is gets inverted by applying inverting tool on the final image.

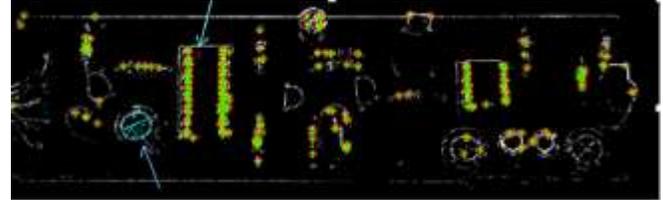


Figure 6: Result of Final Image comparison

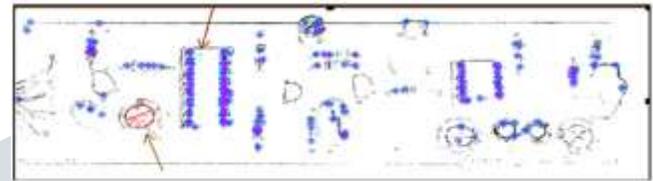


Figure 7: inverted image of image comparison output

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