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PCB FAULT DETECTION USING IMAGE COMPARISON METHOD

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ABSTRACT

This system is designed for the detection of incorrect electronics component and incorrect orientation of electronics components on the printed circuit board. The main purpose of making this system is that to manufacture the printed circuit quickly without any faults in electronics boards. This system is able to identify the incorrect Surface Mount Device as well as non- Surface Mount Device components provided the component is having readable text or color markings on it. Component with no text or markings may not be identified correctly. This system can detect the fault in the test PCB by using image processing methods. In this system image comparison method is used for fault detection. Canny edge detection with PCA algorithm is used for edge detection purpose. During this process some other factors like the tilting angle of the PCB which is put on the plane surface, improper way of focusing light, the distance between the PCB which is kept on the plane surface inside the hardware and the camera which placed above the PCB with fixed position, etc. are very important during processing an image. In this system every time test PCB image is compared with the reference PCB image if the position of components in PCB is incorrect, then it will show by the only red circle in MATLAB.

Keywords: MATLAB, PCB, Image Processing, etc.

I. INTRODUCTION

A PCB (Printed Circuit Board) which is just a plate need to manufacture into an electronic circuit for the proper operation of all the components in any device. This plate needs to flow a list of procedures to make it into an electronic circuit by using a process of cleaning, etching and drilling. There are different ways the PCB gets failure like the design of component, incorrect mounting position of components, overheating, high power supply, etc. All the electronic components are getting connected to each other with the help of the PCB. The PCB defects like an open circuit, over etch, under etch, Pin whole are taking place during the PCB production. For identification of PCB failure problem the template image of correct PCB is compared with the new test image which is manufactured, by applying various types of process on both image find the fault in PCB.

In this system need to design suitable windows standalone application using MATLAB and this application will be installed on any windows machine. To operate the system user need to run the application. This system is capable of identifying the incorrect orientation of components, such as IC and capacitors. . Incorrect component and incorrect orientation will be encircled and properly labelled. This will be displayed in MATLAB. For testing new PCB user requires storing the database on the machine. Therefore, with few settings using MATLAB the system can test any PCB in shorter time. For physical structure need to place the circuit board on a plane surface. And the camera is mounted above this PCB at some distance. This technique requires constant light source and fix camera position. Hence this hardware will be required for the installation of the project. In the process of removing the fault detection from the PCB the MATLAB needs to follow some steps such as noise removal, edge detection, angle tilting, image cropping, thresholding and comparison of the image with the reference image and then the faults from the PCB will be detected. As this function of image processing can be done by a camera. User need to save the image into the computer.

Jithendra P R Nayaka, Anitha K. B. , Dr. Parameshachari B. D., Dr. Reshma Band, P. Proposed a system of fault detection using MATLAB. In this paper they detect the single layer PCB faults such as pattern cut, pin whole, pattern shortly, nick, etc. before the etching process so that the PCB would be reprocessed. The image subtraction and feature extraction methodology is used for finding the fault in PCB. [1]

Akash Kasturkar, Dr. S. D. Lokhande paper presents the detection of faults in PCB by using a process of image segmentation and image processing. In Image segmentation the image divided into basic well defined generic patterns and classification has been developed based on the binary morphological image processing. [2]

Shinde Sarika Sunil, Wankhede Shivraj Ambadas, Shete Supriya Gopinath, et al also defines PCB faults using MATLAB with GUI for easy user interface. Here Weiner filter is used to remove the noise from the image. In this paper they detect fault based on overetch, underetch, or both. They use an image substraction method to detect fault by comparing template PCB and real time PCB. [3]

Snehal Rane, Vartika Rai, Sukeshna Awate paper shows the hardware in which the pic microcontroller is used for controlling purpose. Above the conveyor belt PCB is kept with the help of DC motor the system run and take the snapshot of PCB, this Image stored in PC. The Simple difference algorithm is applied on standard PCB image and PCB image, and the defects can show in MATLAB. [4]

Neelum Dave, Vikas Tambade, Balaji Pandhare paper shows that the mission, vision concept is used for fault detection in PCB like short circuits, open circuits, shorts, missing holes and other defects. With the help of DC motor the conveyor belt runs where PCB is placed. The snapshot of the test PCB and standard PCB image is compared and faults shown in the GUI. [5]

Vikas Krishnaji Salunkhe, Babasaheb Gopal Patil, Suryakant R Dodmise, et al, in this technique they use three testing probes, probe A (red) used for check different test points in good PCB, probe B (green) used for check different test points in faulty PCB and probe (gray) used for common grounds for both PCBs. [6]

Rasika R. Chavan, Swati A. Chavan, Gautami D. Dokhe, et al, shows counter analysis is applied for finding the faults in PCB such as missing components, polarities, circuit breaks, missing tracks, etc. By applying Image subtraction methods they subtract every pixel of the template image from the real image. [7]

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 getting by subtracting test image from the template image, while the negative image is getting by subtracting template image from the test image. [8]

Err. Amit Paul, Err. Gaurav, Err. Poonam Verma shows the fault detection using binary logic. In this system Local Binary Pattern Methods are used for finding the fault in PCB. It is very easy method to detect the fault in PCB. RI-LBP stands for Rotation Invariant Local Binary Pattern which is the next version of LBP. The comparison of the two PCB images they find the fault in Bare PCB as well as component placed PCB in shorter time. For this purpose they use fixed size filter and all PCB belongs to the same category. [9]

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II. METHODOLOGY

The proposed block diagram of the system is shown in following figure 1.

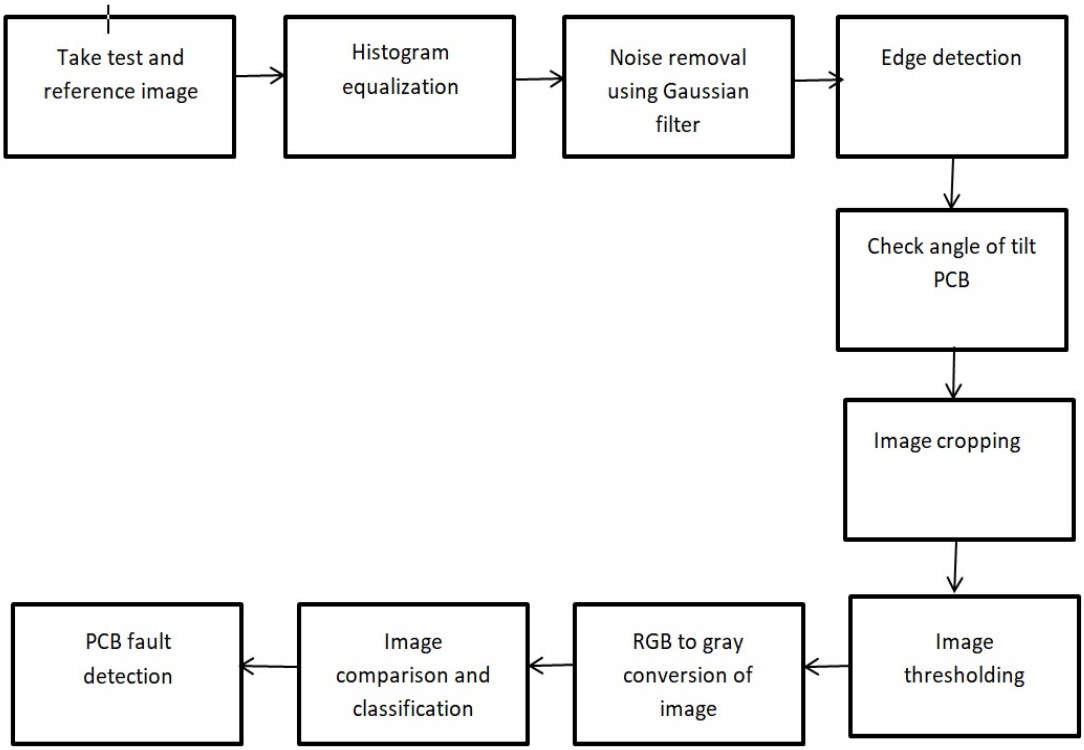

Figure 1: Block diagram of the system

In the process of fault detection, first the database of reference PCB is stored in MATLAB. After that take any one other test PCB containing any fault that test PCB image is stored on desktop of personal computer. After that test PCB image is resized to the appropriate image size by applying the image resizing method to increase or decrease the pixel of an image. After taking the image in appropriate size histogram equalization apply to the test image to improve contrast in the image by enhancing the intensity range of an image, then noise is removed from the test image by using the Gaussian filter, because during the image acquisition or transmission the noise is introduced in an image. Then apply canny edge detection with principal component analysis (PCA) algorithm on the test image for detecting the edges of components which has mounted on printed circuit board. While capturing images from the camera the test PCB gets tilted then and then only image tilt operation apply to the test image otherwise next steps is applied to the image. The unwanted outer information in an image can be cropped by applying image cropping method on the test image. With the help of image thresholding method convert a binary image from an RGB image or grayscale image. Basically, this method is used for drawing the boundary line between the two sets of data to represent the whole image. Before applying Canny Edge Detection algorithm, it will convert into a binary image. For comparison the test image with the reference image, the first RGB color image will be converted into gray image, after that every pixel, shape, and color of the reference image compared with the test image and result shown in MATLAB.

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III. PROPOSED SYSTEM

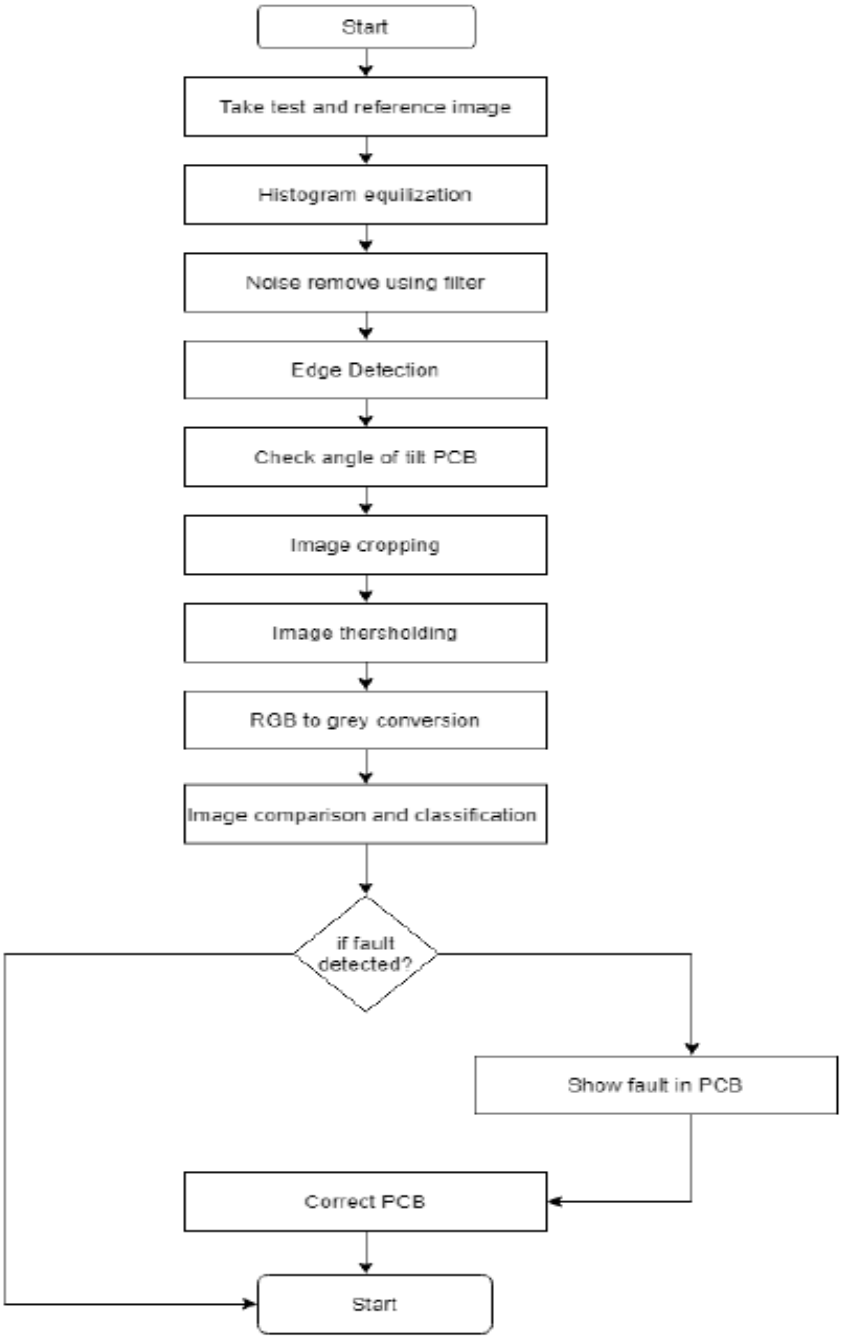

Figure 2: Flowchart of the proposed system

Figure 2 Show flowchart of the process. The basic working algorithm of the fault detection techniques used in this system. The algorithm which is used in this fault detection is called as Image Comparison which can be explained by the above shown flowchart, which states first take the test PCB image of which the fault is to be detected. Another image is the reference PCB. The database of reference image is already stored in the MATLAB. Apply image histogram equalization on the test image to improve contrast in the image by enhancing the intensity range of an image. It only enhanced the given image without losing any information. The noise produced while capturing the test image is removed by using Gaussian filter. This type of filter is used for to compress and enhance the image by suppressing and adding the frequency. After that Canny edge detection with Principal Component analysis (PCA) algorithm is applied to test image for detecting edges of the PCB components. The unwanted outer information in an image can be cropped by applying the cropping method.

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Thresholds consist of only two fixed values. After applying images thresholding image it will convert into grayscale image. As per the edges found in the edge detection method the image comparison will be done based on the reference image. Now in the next step if the comparison of images shows any fault then the fault is shown in graphically in MATLAB.

IV. RESULTS AND DISCUSSION

This section describes results obtained by experimentation. At first, good quality image of the circuit board with correct orientation of electronics components is obtained and saved to use as a reference image for fault detection of other circuit boards. The test image is taken to the desktop of personal computers. After that, apply Canny Edge Detection algorithm to test image. Every time needs to compare reference PCB images with test PCB, depending upon the shape, color and pixel of two image they process, if the position of the components on the PCB is incorrect, then it will be indicated only by the red circle. The incorrect position at IC can be identified based on notch which is present on IC. The match portion of the component is indicated by a plus sign inside the red circle. In order to capture every new test PCB image proper light intensity and fix camera position is needed, if the light is not in proper intensity, then the shadow will be present in image and if the position of the camera is not fixed then blur will add in an image. For taking an accurate image of a PC.

A. Reference Image

Figure 3 show a correct reference PCB image. For finding the fault in test PCB every time correct reference PCB image is take for comparison purpose. The correct reference PCB image is works as input image. For finding fault in PCB test PCB image compared with reference image with the help of pixel information, colors and shapes of the components.

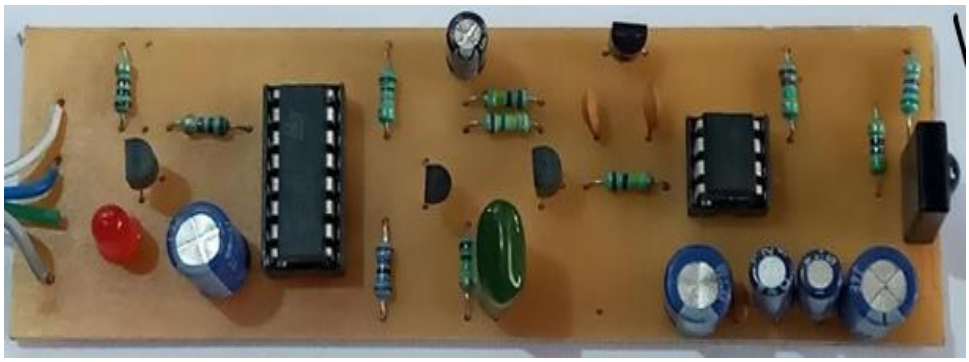

Figure 3: Correct reference PCB Image

B. Test Image

Figure 4 show a test PCB image. In big electronic device manufacturing industry the large amount of PCB was not works properly hence to improve the quality of PCB without and defects every time test PCB image is compared with fixed reference PCB image which is stored in the MATLAB. The incorrect position of integrated circuit is identified using IC notch which is present on the IC. It also finds the fault in capacitor. The fault of capacitor is identified with the help of circle which is present on the top of the capacitor.

Figure 4: Test PCB Image

C. Binary image

Figure 5 show a binary image of test PCB. 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.

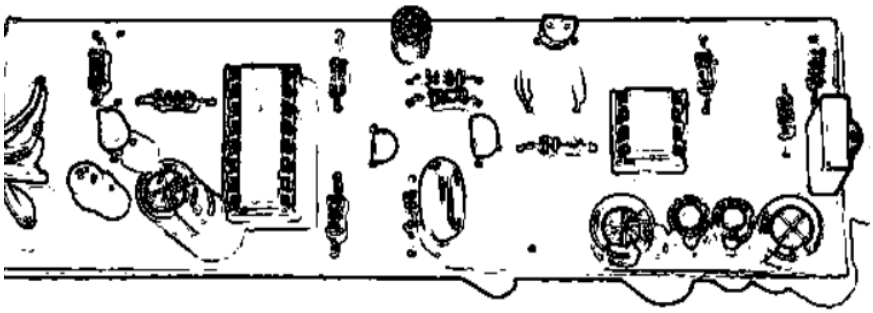

Figure 5: Binary image

D. Grayscale Image

Figure 6 show a grayscale image of the test PCB. 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.

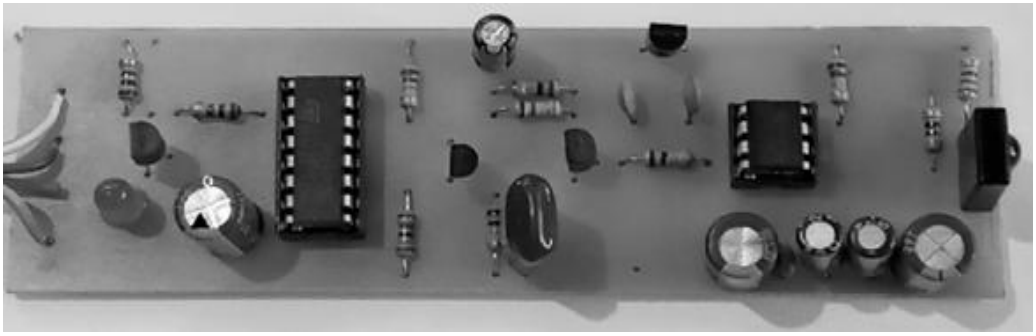

Figure 6: Grayscale Image

E. Result of Canny Edge Detection Algorithm

Figure 7 show the output after applying the canny edge detection algorithm. It is very important while applying the canny edge detection algorithm on the test PCB, the image must present is in the binary form. Once the canny edge detection algorithm is applying on the test image the binary image is get converted into grayscale form, because of gray color contains gray shades only hence while comparing the test image with the correct reference PCB image it contains less information. The canny edge detection method is very more powerful edge detection method than others method, because of this method detects the strong edges of components only and also week edges of components only when this week edges is get connected strongly with strong edges of components.

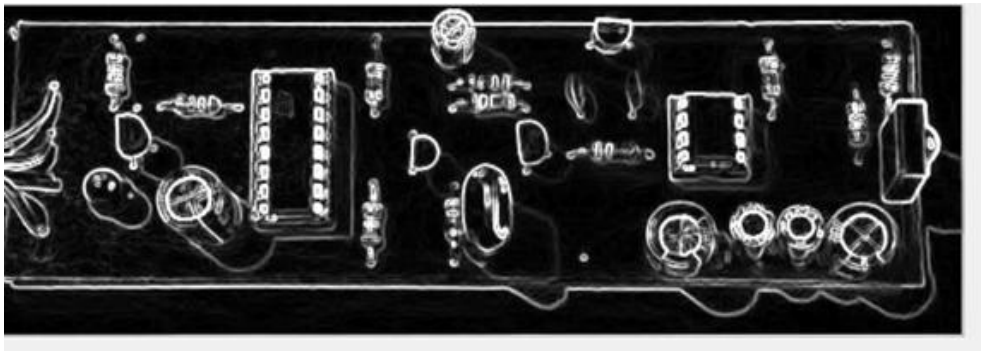

Figure 7: Result of Canny Edge detection algorithm

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F. Final Image Comparison Output

Figure 8 show the final output of image comparison method in which test PCB image is compared with the correct reference PCB image which is already stored in the MATLAB. On this PCB the position of two components are wrong. The Integrated circuit is placed reverse way hence it can be indicated by only red circle. And the legs of capacitor is also mounted opposite hence it does not match with the reference PCB image.

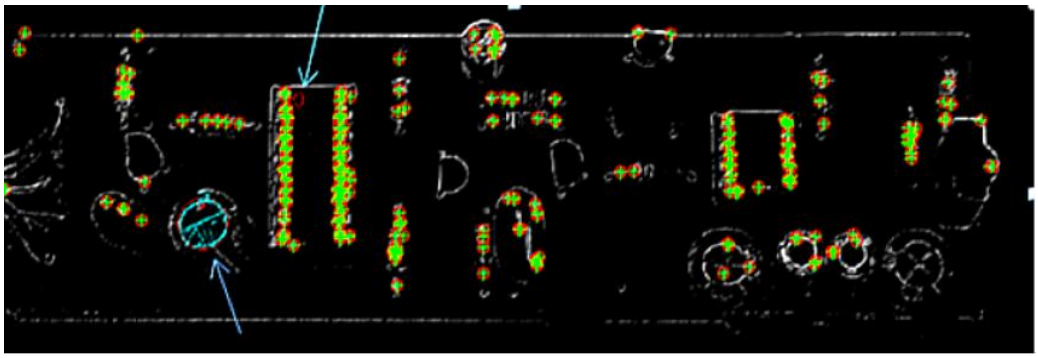

Figure 8: Result of the final image comparison output

G. Inverted Image of the Final Image Comparison Output

Figure 9 show the inverted image of the final image comparison method. To see the fault clearly on the PCB the comparison output image is getting inverted by applying inverting tools on it. Firstly, open the image inverted tool, then added a PCB comparison output image by clicking on edit option. After that click invert option of inverting the image and this inverted image was saved by clicking the save option.

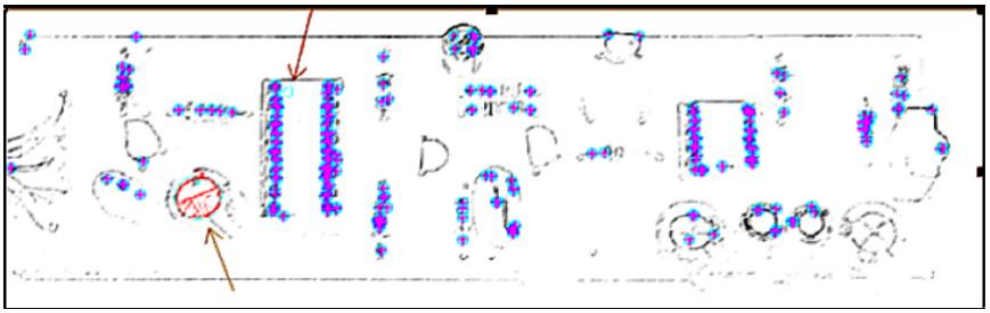

Figure 9: Inverted image of the final image comparison method

H. Test PCB image at improper light Conditions

Figure 10 show the result when the position of the camera and the light both are not in good condition. Above both conditions are not in proper ways during image comparison process, hence the shadow of components and blur in the image has been present.

Figure 10: Test PCB image at improper light condition

V. CONCLUSION

In this work, the incorrect position of components such as capacitor and IC is identified using image processing technique. This system uses reference PCB image and their characteristics such as shape, color and pixel etc. which are already saved in the database. By applying image comparison method, the reference PCB image is compared with the test PCB image. It is very important that the light condition and position of the camera must be uniform and that all inspected PCB belongs to the same category. The Canny edge detection with Principal Component Analysis (PCA) algorithm is used to detect the component edges of the PCB. For testing new PCB it is necessary to store the new reference PCB image in the database. If the position of the component doesn't match with the reference PCB then it is indicated only by the red circle.

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