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Application of Image Processing using Computer in Detection of Defective Printed Circuit Boards

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Abstract: In these days, image processing has been used in many applications. It is the process for performing the different operations on the images using various functions. In this paper, image processing is used for finding the defective printed circuit boards. For finding the defective printed circuit boards, the parameters like entropy, standard deviation and euler number has been used. The result shows the effectiveness of the proposed method.

Keywords: image processing, printed circuit boards, defects, defective printed circuit boards, standard deviation, euler number, entropy.

I. INTRODUCTION

Nowadays image processing using computers is widely used in many applications like industrial applications, reconnaissance, remote sensing, fingerprint or face recognition, automatic character recognition, x-ray imaging, space image processing, computerized photography[1]. It is a process to perform the various operations on an image to extract information from it and to get the enhanced image from it using digital computers [2]. In this paper, image processing is used for detection of defective Printed circuit Boards. In general, Printed circuit board gives mechanical support to the different electronic components when placed on it. So it is important to detect the defective PCBs for quality assurance. Manufacturing process of electronic devices involved many steps. So it is important to detect the Printed circuit boards in the first stage of manufacturing.
Fatal and potential types defects are found on bare PCBs [3]. Fatal defects are those in which PCBs do not attend the objective for which they are designed for [4]. Potential defects are those in which performance of PCBs have compromised [4].
Numbers of defects present on bare PCBs are shown in fig. 2 and defect free PCB image is shown in fig.1. In the past year, most of the detection of Printed circuit boards had done by human inspectors, which suffers from many problems like slow, cost of the process, more errors etc. [5]. But now a days, automated inspection systems have come into existence which uses many techniques like wavelet transform [6], fuzzy[7], mathematical morphology[8], fluorescent light[9], quantile - quantile plot [10].
In the next section material and methods used for proposed technique have been described. The experimental results and discussion are illustrated in Section III and finally the conclusion is made in Section IV.

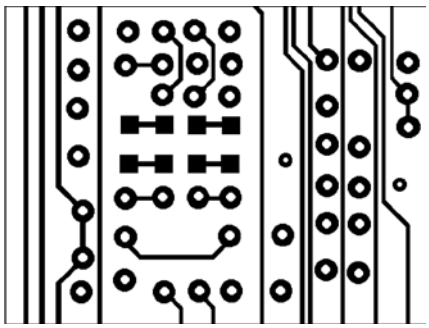

Figure1 Defect free image [5]

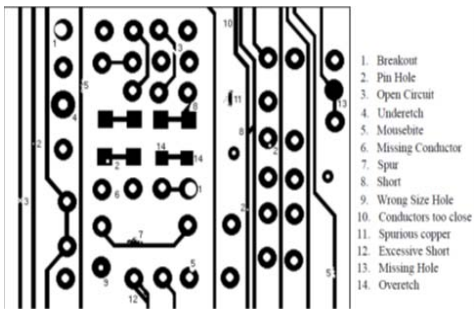

Figure2PCB image with defects [5]

II. MATERIALS AND METHODS

Printed circuit boards are detected by many automated systems. In this paper, different parameters like entropy, standard deviation and euler number have been used for image matching purpose, which describe the similarity between the two images(reference and test image) for checking of defective PCBs.

2.1 Entropy

Entropy determine the value of the expected value of the information present in the message. The characterization of

texture of input image can be measured by using it [11]. Mutiscale analysis, image registration and feature selection are the major areas of applications of entropy [12-14].
Mathematically, it can be calculated as:
Entropy=sum (p.*log2 (p)) (1)
where p contains the histogram counts.

2.2. Standard deviation

Standard deviation gives the measurement of variability. For the measurement of variation or dispersion from the average values of pixels, standard deviation has been used [15]. The closeness toward the average value has been indicated by low standard deviation whereas the spread out of the data over the long range of values has been indicated by the high standard deviation. Mathematically, it can be calculated as:

$$a(x,y) = \sqrt{\frac{1}{mn-1}\sum_{(r,c)\in w}\left(b(r,c) - \frac{1}{mn-1}\sum_{(r,c)\in w} b(r,c)\right)^2} \quad (2)$$

where a(x,y) is the standard deviation of resultant image
b is the input image
'r' and 'c' are row and column
mn is the size of an image
w is the window or mask

2.3 Euler number of binary image

The euler number is the total number of objects in the image minus the total number of holes in those objects [16].
Mathematically, the euler number (e) of a binary image can be calculated as:

e= n – h (3)

Where n is the number of connected components of the object
h is the number of holes in the image

The euler number has been successfully applied for image analysis and visual inspection over binary images [17].
In this paper, above parameters have been used for finding the defective PCBs. In addition to this Graphical User Interface (GUI) using MATLAB software has been made for making the proposed method user friendly. GUI has the capability of using computer graphics to make the program easy to learn [18]. In GUI, instead of using command lines, the icons and visual indicators have been used [19].

III. RESULTS AND DISCUSSIONS

The proposed method has been implemented using MATLAB software. Figure 3 has been taken as reference image and figure 4 to figure 7 hasbeen taken as test images.

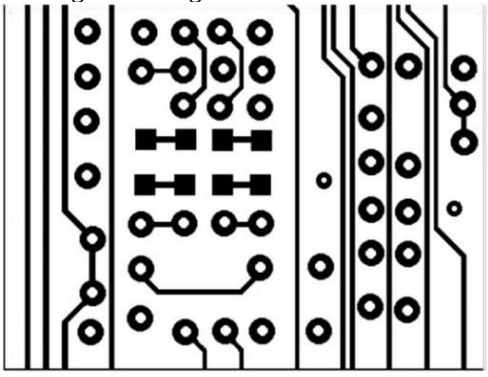

Figure 3 Reference image

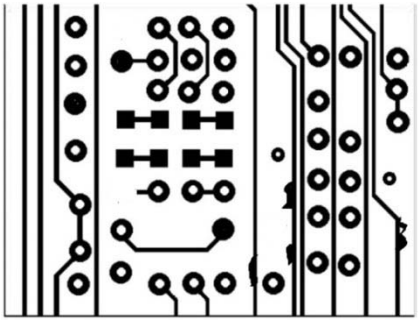

Figure 4 Test image 1

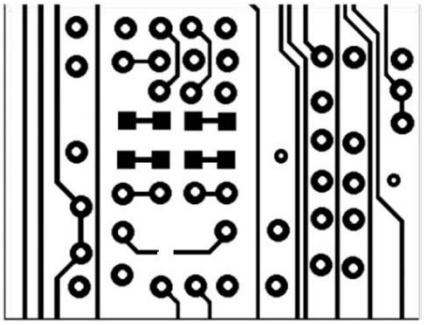

Figure 5 Test image 2

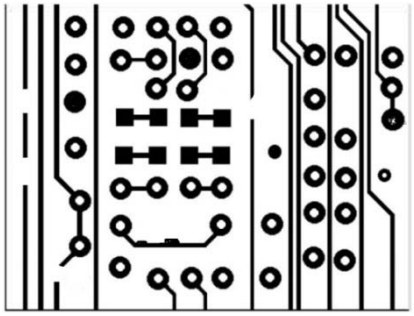

Figure 6 Test image 3

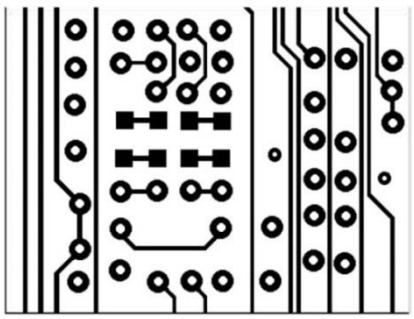

Figure7 Test image 4

Table I Mathematical analysis for detection of defective PCBs

Images	Entropy	Standard Deviation	Euler Number
Reference image	3.50446	0.429264	7
Test image 1	3.50714	0.427887	5
Test image 2	3.53931	0.427574	6
Test image 3	3.49247	0.425943	4
Test image 4	3.50446	0.429264	7

From the table 1, it has been observed that reference image and test image 4 has the similar mathematical analysis as compared to other images. Hence, test image 4 is defect free PCB and other test images (1,2,3) are defected.
To make the proposed method effective and user friendly, Graphical User Interface has been made, shown in figure 8.

Figure 8 Snapshot of proposed GUI for finding defective PCB

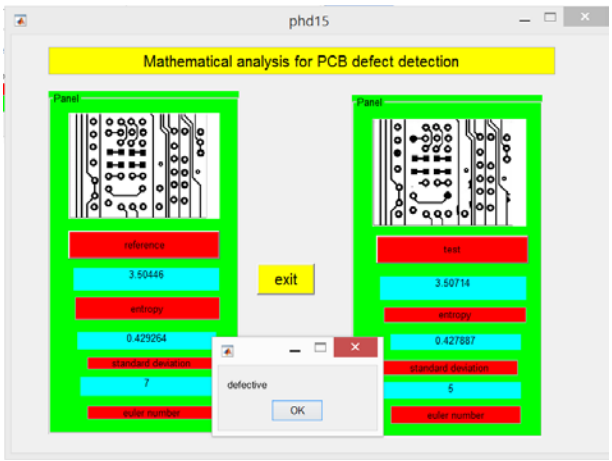

Figure 9 Snapshot of GUI for finding defective PCBs using reference and test image 1

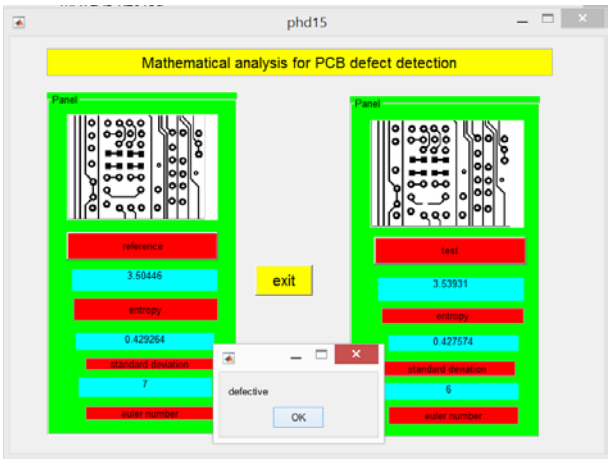

Figure 10 Snapshot of GUI for finding defective PCBs using reference and test image 2

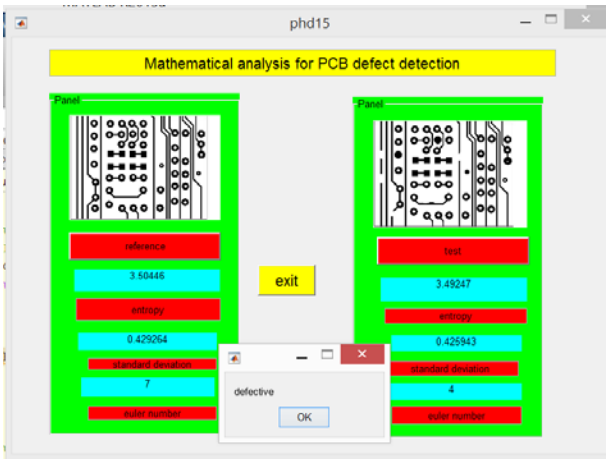

Figure 11 Snapshot of GUI for finding defective PCBs using reference and test image 3

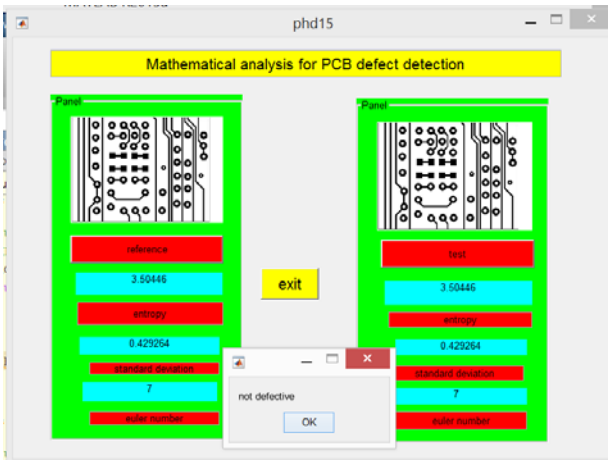

Figure 12 Snapshot of GUI for finding defective PCBs using reference and test image 4

Figure 8 shows the snapshot of proposed GUI for finding the defective PCBs. In this, entropy, standard deviation and euler number has been taken as mathematical parameters for comparison of test and reference images. Figure 9 shows the GUI for finding the defective PCB (test image 1), the values of entropy, standard deviation and euler number of reference image and test image 1 are different(not similar with each other). Hence test image 1 is defective PCB.
Figure 10 and 11 shows the snapshot of GUI for finding defective PCBs for test image 2 and 3. The values of entropy, standard deviation and euler numbers of reference image and test images are different, therefore the test images (2 and 3) are defective.
Figure 12 shows the GUI for finding defective PCB for test image 4, the values of entropy, standard deviation and euler number of reference and test images are same. Hence the test image 4 is defect free

IV. CONCLUSION

The detection of Printed Circuit boards are important task in manufacturing process. If the defect occurs in first stage of manufacturing, then the proposed method is significant. From the above results, it has been concluded that test images 1, 2 and 3 are defective. So the next step to find the defects will only be implemented on defective PCBs instead of all. As a result of this, the proposed method is time saving.

V. REFERENCES

[1] http://fourier.eng.hmc.edu/e161/lectures/e161ch1.pdf
[2] https://sisu.ut.ee/imageprocessing/book/1
[3] A.P.S. Chauhan, S.C.Bhardwaj, "Detection of Bare PCB Defects by Image Subtraction Method using Machine Vision", World Congress on Engineering (2011).
[4] B.Kaur, G.Kaur, A.Kaur, "Detection and Classification of Printed Circuit Boards defects", Open Transaction on Information Processing, Vol.1, No.1 (2014), pp.8-16.
[5] M.Moganti, F.Ercal, C.H.Dagli, "Automatic PCB Inspection Algorithms: A survey", Computer vision and image Understanding, Vol.63, (1996), pp.287-313.
[6] Z. Ibrahim, S.A.R., Al-Attas, Z. Aspar, 2002, "Analysis of the Wavelet –Based Image Difference Algorithm for PCB Inspection", SICE Annual Conference, Vol.4, pp.2108-2113.
[7] H. Rao, C.H.Wu, W.J. Shiang, Y.T. Fang, 2009,"Fuzzy Reasoning for PCB Inspection", IEEE International Conference on Machine Learning and Cybernetics, pp. 3052-3057
[8] S.H. Indera Putra, Z. Ibrahim, 2010, " Printed circuit Board defect detection using mathematical morphology and MATLAB Image Processing tools", IEEE International Conference On Education Technology And Computer, pp. 359-363
[9] Y. Hara, H. Doi, K. Karasaki, T. Iida ,1988, "A system for PCB Automated inspection using fluorescent light", IEEE Transaction on Pattern Analysis and Machine Intelligence, Vol.10,No. 1, pp.69-78
[10] D.M. Tsai, C.H. Yang, 2005, "A Quantile-Quantile Plot Based Pattern Matching for Defect Detection", Pattern Recognition Letters 26,pp.1948-1962
[11] Gonzalez, R.C., R.E. Woods, S.L. Eddins,(2003), *Digital Image Processing Using MATLAB*, New Jersey, Prentice Hall, Chapter 11.
[12] S.Bian, P.Shang,(2016)," Refined two index entropy and multiscale analysis for complex system", Commun Nonlinear SciNumerSimulat 39, pp. 233-247
[13] X. Zhang, C. Mei, D. Chen, J. Li, (2016),"Feature selection in mixed data: a method using a novel fuzzy rough set-based information entropy", Pattern recognition 56,pp.1-15
[14] L.Chaoliang, M. Lihua, Y.bmin, C.Shumin,(2016),"Regional information entropy Demons for infrared image nonrigid registration",Optik 127,pp. 227-231.
[15] V.Kumar, P.Gupta, 2012, "Importance of Statistical Measures in Digital Image Processing", International Journal of emerging technology and advanced engineering, pp.56-62
[16] MATLAB 2015a
[17] J. H. Sossa-Azuela1, R. Santiago-Montero2, M. Pérez-Cisneros3, E. Rubio-Espino1, "Computing The Euler Number Of A Binary Image Based On A Vertex Codification", Journal Of Applied Research And Technology 361vol.11,June 2013 ,pp.360-370
[18] http://www.webopedia.com/TERM/G/Graphical_User_Interface_GUI.html
[19] https://www.computerhope.com/jargon/g/gui.htm