International Journal of Advanced Science and Technology
Vol. 29, No. 4s, (2020), pp. 1205-1210

Defect Detection in PCB Using Image Processing

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Abstract

Modern Printed Circuit board (PCB) has distinctive electronic parts mounted with various pathways or tracks. The idea of visual printed circuit board (PCB) assessment is a methodology used to detect the counter difficulties that can emerge during people's manual review. A PCB standard picture and a defected PCB picture are taken as input and utilizing a basic subtraction calculation or logical X-OR that can feature the principle issue areas. At last, deformity classification activity is utilized to detect four kinds of imperfections to be specific, they are pinhole, spur, short circuit, and open circuit.
Keywords- *Printed Circuit Board, Defect detection, Image processing, Thresholding.*

1. INTRODUCTION

A printed circuit board (PCB) is utilized to produce many electronic products without any errors. During the assembling of printed circuit sheets, widths of transmitters and covers can modify on account of assembling deformities, for example, dust, underdrawings over the carving and deceptive metals. The copper board will experience the "stripping process, where the circuit design will be preserved while the rest of the copper foundation will be cleaned out. To decrease scrap brought by the wrongly carved PCB board, an investigation must be done in the early stage. To cut the assembling costs related to bare PCBs, the assessment of them is required as the prime advance of the assembling procedure.

The programmed visual examination is significant because it detects the faults in PCB and gives quick and quantitative evaluations. It helps in the human administrator from tedious, exhausting, and dreary errands of review. PCB review procedure could be classified into two fundamental stages: (1) The deformity discovery and (2) The imperfection classification. In deformity identification, it isn't critical to know the kind of imperfections. In any case, in deformity classification, it is required to know the sort of the identified imperfections. Imperfection classification will occur after the deformity discovery instrument has been completed.

In modern times, estimation of production is normally done in two different ways, contact and contactless. In the contact estimation approach, the tasks are done completely outwardly and the measure of mistake is very huge. The exhibition of this technique is exceptionally low, particularly in regions requiring exact estimation. In the non-contact estimation approach, these tasks are cultivated through at least one camera and an image processing software. The various highlights of the items can be handily identified right now gives quick arrangements as indicated by the presentation of the PC framework utilized.

Trial research works have demonstrated that the proposed approach can finish tasks with high precision and speed. In the machine vision methodology, there will be control over the gaps on the PCBs, which decides the properties, for example, the number of gaps and the deformity. As per the outcomes acquired in the investigation, the proposed approach can work with a sum error rate. In this approach, a CCD camera,3-pivot situating framework, light source, and PC are utilized. The proposed approach is essentially a foundation extraction process and the limits of the items going through the transport have been resolved. In the test studies, it has been seen that the proposed approach gives quick and precise outcomes. Example of a good PCB is shown in Fig.1

ISSN: 2005-4238 IJAST

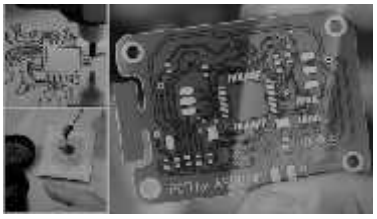

Fig. 1. Example of a good PCB of Arduino

2. PROPOSED APPROACH

Toward the start of the fields where machine vision applications are utilized, there is an imperfection identification. It is planned to decide the inadequacies of the items going through a means of transport and convey great and complete items to the end client. As a rule, covers the last phases of machine vision applications, deficient items are identified and isolated from the transport. Right now, location and deformity recognition forms are chiefly produced for machine vision applications.

The proposed approach fundamentally utilizes highlight extraction and highlight coordinating activities. Thresholding and other techniques are utilized in the component extraction process. For a reference picture, the outcomes acquired from this procedure are put something aside for some time in the future. A similar procedure is applied to the test pictures that follow this procedure lastly the deformities on the PCB are recognized together with the element coordinating procedure. A flowchart describing the proposed approach is given in Fig.2.

In the proposed approach, the image of the PCB is taken firstly through a camera. This image is transmitted to the main channel and the image processing algorithm is executed in the first step of the algorithm.

In the next step of the proposed approach, the optimal threshold value of the image is adaptively determined. The reason for using the thresholding method is to be able to clearly show all the details in the image, the image is converted to a binary image by using thresholding method.

$$G(r) = \frac{1}{(2\pi\sigma^2)^{N/2}} e^{r^2/(2\sigma^2)}$$

As of the next step in the algorithm, the noise in the image is eliminated if present by using the Gauss filter. The mathematical expression that performs this operation is presented in Equation.

The contour or edge extraction method is applied to the image obtained. At this point, all the edges in the image are precisely defined. After this process, a morphological opening process is applied to the image. This process thickens the edges of the resulting image.

A. Image acquisition:
The picture of the Printed Circuit Board without any deformities is stacked on to the PC. While catching the picture appropriate light source is given. The picture caught is stacked on to the PC. This progression implies getting the picture that will be checked for surrenders which could be of different picture configurations, for example, bitmap (.bmp), compact system designs (.png), JPEG (.jpg), and so forth. Another Template/Reference picture of an imperfection free PCB is taken as info which could likewise be of the equivalent or distinctive picture position. Through a function called imread(ImageName.ImageFormat) image acquisition is done.

B.Gray Scale Conversion:
The Image of the PCB which is to be tried is to be supplemented for subtraction and imperfection discovery. The supplementing of an RGB picture must be finished with the assistance of changing over the picture to Gray-scale and afterward supplementing. The dark scale transformation is finished with

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the RGB2Gray(ImageName.ImageFormat). For Image supplement, every pixel estimation of the picture is subtracted from 255.

C. Thresholding:

Image thresholding is a straightforward type of picture division. It is an approach to make a paired picture from a grayscale or a full-shading picture. This is normally done to isolate "item" or frontal area pixels from foundation pixels to help in picture handling. In thresholding, there will be a threshold value which is set by the user. The pixels in the image which are having lower value than the threshold value will be set to zero and the pixels which are having higher value than the threshold value are set to one.

D. Image Subtraction:

Image subtraction or pixel subtraction is a procedure where the advanced numeric estimation of one pixel or entire picture is subtracted from another picture. This is accomplished for one of two reasons – leveling lopsided segments of a picture, for example, a large portion of a picture having a shadow on it, or identifying changes between two images. This recognition of changes can be utilized to tell if something in the picture moved. This is generally utilized in fields, for example, astrophotography to help with the electronic quest for space rocks or Kuiper belt protests in which the objective is moving and would be in one spot in one picture.

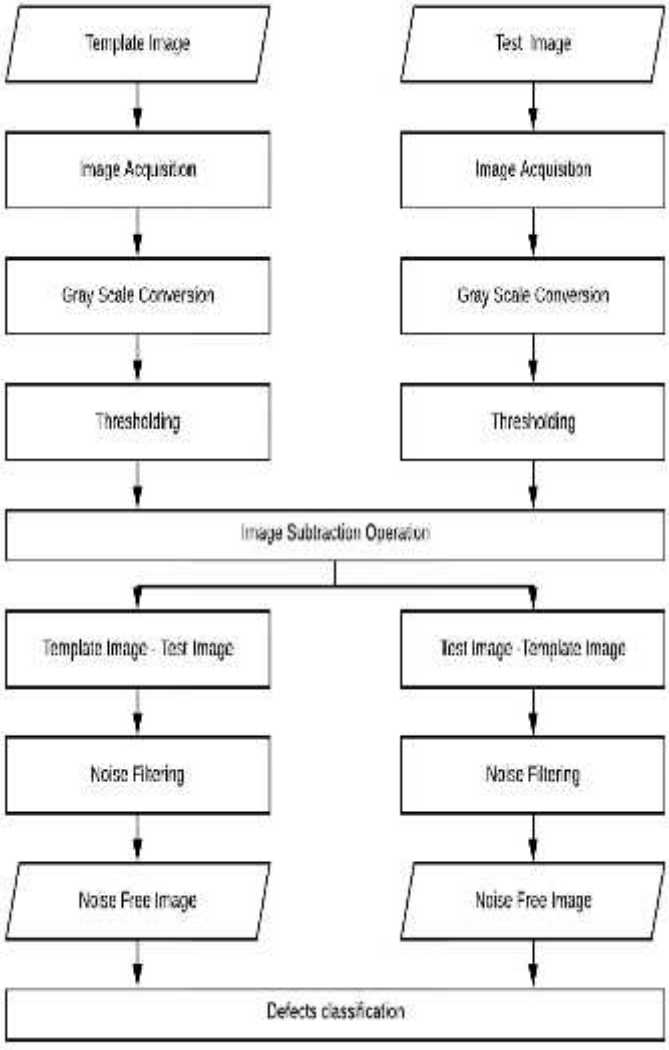

Fig. 2.Block diagram of the proposed system

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E. Defect Classification:
The client needs to give the contribution to the imperfection he needs to test. Four kinds of imperfections have been shrouded in the undertaking till now which are as per the following:

1) Open Circuit: At the point when a PCB miniaturized scale stripline/transport line gets broken then the current/voltage can't pass, consequently this sort of imperfection is called as Open circuit since it makes an open circuit on the PCB causing infinite opposition. Short Circuit: A short circuit is an issue in an electrical circuit where at least two wires that shouldn't interact with one another touch. A short out can bring about an exceptionally high current flow through the circuit. In the PCB if there are any short circuits then it will cause great damage to the components surrounding it and in turn, results in malfunction or burning of the board.

2) Spur: In a PCB there is a chance for anonymous growth or deposit which leads to malfunctioning in the function. Thus it has to be detected using some algorithms for a good PCB.

3) Pinholes: Pinholes are available to mount electric components on the PCB. Thus the etching process has to be done properly as there is a chance for missing pinholes. Apart from missing pinholes, there can also be extra pinholes which can be considered as defects in PCB.

4) Output: The defects can be observed from the resultant image. Image subtraction or Xor operation is performed between the template image and test image. The defects are highlighted using some algorithms so, different defects are indicated with different colors on the resultant image.

3. IMPLEMENTATION

The images shown in Fig. 3 are template & test images which are subjected to the defects detection algorithm, which is known as Image acquisition in gray scale . Then these images are thresholded and the images are shown in Fig.4. Later the images are subtracted from each other which is shown in Fig.5.Afterwards these images are checked for noise and then they are applied to morphological opening and the defects are classified.

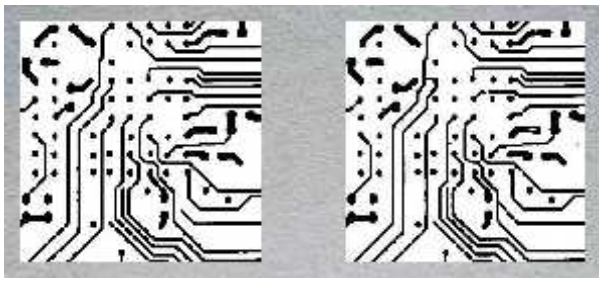

Fig. 3 Template and Test Images

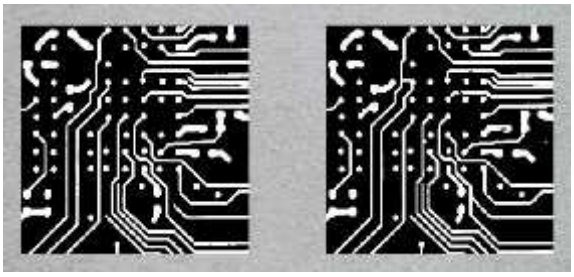

Fig. 4. Images after Thresholding

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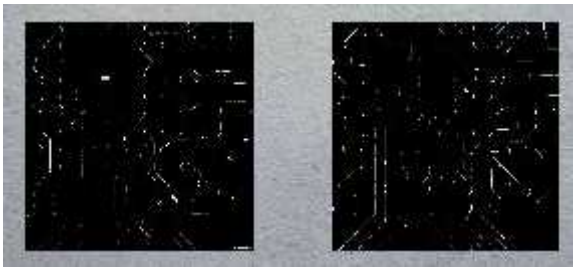

Fig. 5. Images after Subtraction

4. CONCLUSION

Pictures taken through a constant camera were broken down with the image processing algorithms and are further processed to detect defects present in PCB. Primarily two images were taken namely, a template image and a test image. These two images were first acquired later grayscale conversion and thresholding is done individually.

A framework to identify and group defects in PCB is created based on the calculations mentioned above. The image subtraction method or Xor operator method is used. Checking for defects on PCB is a must done step to prevent malfunctioning of devices in which these boards are used. In this paper, an imperfection recognition strategy dependent on machine vision has been created.

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