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PCB DEFECT DETECTION AND CLASSIFICATION USING IMAGE PROCESSING

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ABSTRACT:

The Printed Circuit Board (PCB) is in most electronic products such as television, mobile, washing machine, computers, etc., used for mechanical support and connecting components along electric conductive tracks. The main goal of this project is to provide defect detection technology using the RANSAC algorithm in image processing engineering. A failure in PCB can cause a system-wide or circuit failure. Mainly PCBs are classified into two types – Bare PCBs & Assembled PCBs. Here, to identify the defect in bare PCBs, the RANSAC algorithm and image subtraction process are done. The PCB images are captured in real-time and processes them using MATLAB.

Keywords: *Blob, Image subtraction, Match correspondence, SURF feature technique, RANSAC Algorithm.*

1. INTRODUCTION

A Printed Circuit Board is the most important element in an electronic circuit. PCBs are used for reducing the size of electronic products. It is also called as Printing Wiring Boards. At the time of manufacturing of PCB, many defects are detected which suppress the performance of the circuit. For conduction, the circuits are designed on the boards with copper tracks rather than wires for the supply of electricity between the electronic components. If it is a simple circuit, single layer board could be enough. As the circuit complexity increases, it is suggested to go for a double-layer board or use more than two layers, as in a multi-layered board. Here, the PCB defect detection is done on a single layer of bare PCB.

2. LITERATURE SURVEY

G. Prathima (2020) has been published a paper based on Defect Detection in PCB Using Image Processing the proposed approach is done by using XOR operation, where one pixel or entire picture is subtracted from another picture.

Pachpind Rahul (2019) has proposed a paper on the topic of Bare PCB Defect Detection Using Raspberry Pi. This paper gives a solution to identify the defect in PCB by machine vision. Connect the camera to the Raspberry Pi to capture an image of the Printed circuit board (PCB) and compare this captured image with the original image of the circuit board. A photoelectric sensor is used to detect the position of the printed

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circuit board, and this sensor emits light rays from its light emitting element. Reflective sensors are used to detect the rays reflected from the target. This indicates the location of the printed circuit board on the conveyor. The first step is to launch the conveyor, detect the location of the circuit board on the conveyor, capture this image with a camera, remove the background image from the original image, and preload the captured image on the circuit board. Is to merge with the image. In the database to compare. If there is a defect, it means that the defective PCB is isolated, and if there is no defect, it means that it is output as a defect-free PCB.

Kowsalya. P (2018) has published a paper under the title of Printed Circuit Board Fault Detection. The extra point in this paper is the reference image is converted from RGB to grey-scale image and then to binary image for easy and simple processing. The logical XOR operation will show us the defect in the inspected image compared with the reference image.

Manasa H.R. (2016) proposed an article on defect detection of assembled printed circuit boards by image processing using LabVIEW. In this article, we will take the test image and the reference image as input for preprocessing, convert the image as an array, and then compare it to the array values of the two images. Color images are converted to array values. This value is expressed in 32 bits per pixel. LabVIEW indicates where to start the image to match the reference image. Adjust the percentage between the two images. If the match rate is below that and the shapes do not match, the board will fail and the results will be displayed accordingly.

3. PROPOSED SOLUTION

PCB defect detection is mainly classified into two category,

1) Image subtraction

2) Feature extraction

One of the feature extraction methods is Speeded Up Robust Feature (SURF). Extract features from the two images and compare them to one of the SURF parameters, the metric threshold, which is the strongest feature threshold. Then a random sample consensus (RANSAC) matches the two images (inliers).

In the pre-processing stage edge and noise, detection is done. For edge detection canny edge detection algorithm is carried for a wide range of detection in a complex image. Here additive white noises are found it is meant for Gaussian so a Gaussian filter is used. A low-pass filter for removing high-frequency noise in digital images. It is superior to other filters because it separates frequencies much better.

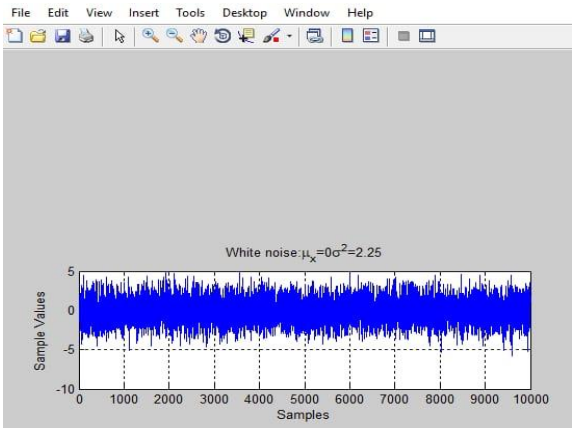

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Fig 1 White Noise

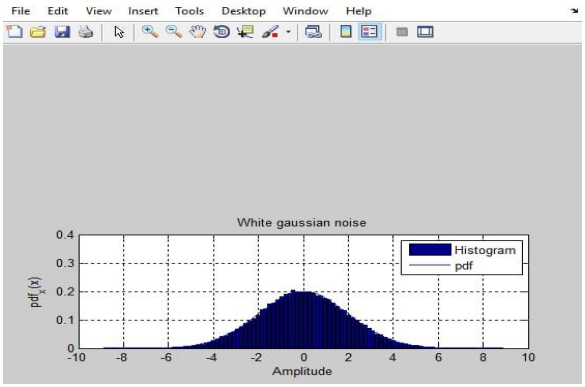

Fig 2 White Gaussian Noise

The absolute value of Gaussian noise depends on the standard deviation (sigma). The amount of noise and the sigma value are directly proportional to each other

$$(1)\ \text{Standard deviation } (\sigma) = \frac{\sqrt{\sum_{i=1}^{n} (Xi\text{-}X')\ \wedge\ 2}}{n}$$

	1	2	3
1	0.0947	0.1183	0.0947
2	0.1183	0.1478	0.1183
3	0.0947	0.1183	0.0947

Fig 3 Matrix form of After Removing Noise

SNR is described as signal-to-noise ratio. Ratio between desired signal and undesired signal such as background noise.

FORMULA

10 log (max-min)/std

Max – maximum value

Min – minimum value

Std – standard deviation

Here the maximum value is the pixel value of an image that is 255 and the minimum value is 0, and std is Standard deviation, the Standard deviation value is **41.7853,** and the SNR value is **18.0872.**

3.1 SURF TECHNIQUE

There are two types of functional techniques in the Robust Algorithm. That is Sift and Surf features. Speeded up Robust Feature is a fast and robust algorithm. It is used for local, similarity – invariant representations and comparisons between two images. When Compared to Sift technique surf is better because it

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is fast and anyone feature is enough to compute the result. SURF follows the same procedure as SIFT (Scale-Invariant Feature Transform), but it considers only one feature only. Speeded Up Robust Feature is used to detect object.

3.2 MATCH CORRESPONDENCE

The SURF feature technique matches the correspondence between two images by using the RANSAC algorithm. The feature is used in SURF is the Matric threshold. To fix the Matric threshold value we get matching correspondence between two images that are inliers.

Inliers – It means matching points between original and distorted images, the RANSAC algorithm is used to extract matching points (inliers).

Outliers – It consists of both matching and mismatching points of an image.

Here Metric Threshold is fixed as 600 for accurate matching point. If it is below 600 it match lot of matched points. If above 600 means it match less matching points.

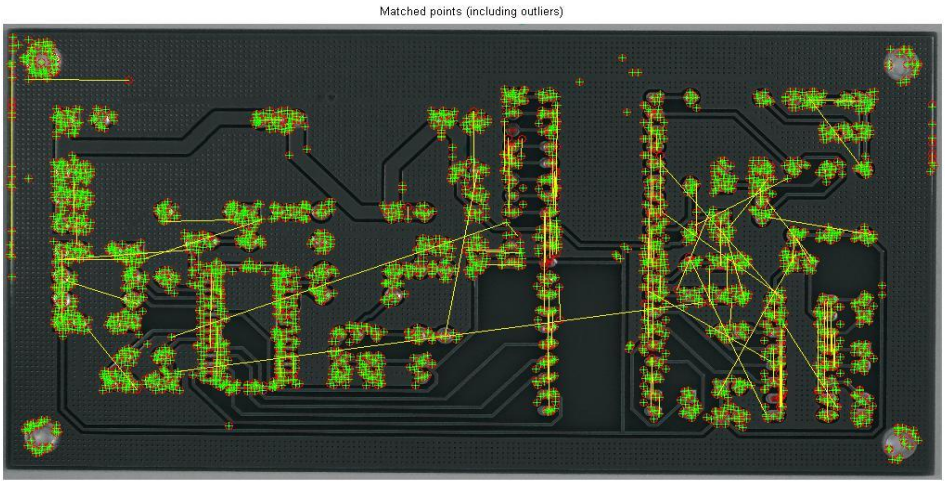

Fig 4 Matched Points (including outliers)

Fig 5 Matching Points (Inliers only)

3.3 IMAGE ROTATION

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The input for image rotation is an image. All this is to rotate the image by an angle θ. Image rotation is a common image processing technique that uses image matching, alignment, and other image-based algorithms. Rotate the distorted image by θ = 30 ° to find a match between the original image and the distorted image.

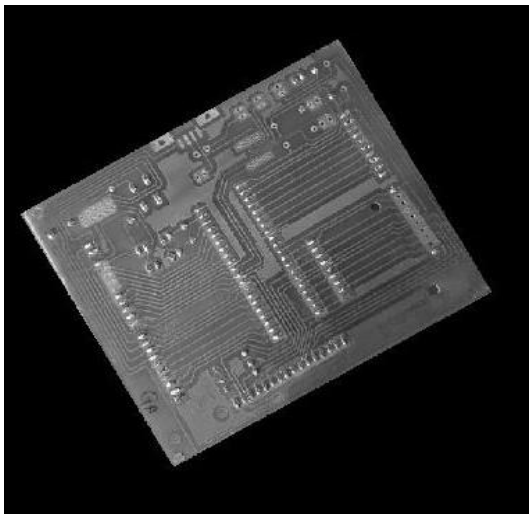

Fig 6 Image Rotation

3.4 IMAGE SUBTRACTION

Image subtraction or pixel subtraction is the process of subtracting a digital value for a pixel or an entire image from another image. This operation is done for two main reasons. One is to smooth out uneven areas in the image, or simply to say that the shadows of another image hit the first image. Therefore, one image and the other image rotate in the same way. Then run the image subtraction process. The next reason is to recognize the changes between the two images. This is used to identify the area of this sample image.

3.5 BLOB

Blobs are the basic method of image processing used to analyze object shape features such as counts, areas, and positions. Blob gives the exact fault region get separated from the PCB image after the Image Subtraction Process.

Fig 7 BLOB

3.6 WORKING

Captured PCB image from lab and the features of an image has been extracted by using SURF Technique in MATLAB. Then Match the correspondence between original and distorted image by using RANSAC algorithm. Image Subtraction is used to subtract the original image from defected image and the blob is used to separate the fault region.

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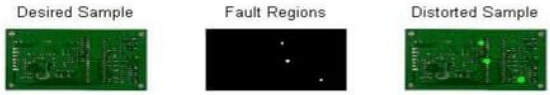

Fig 8 Result

Here the missing hole defect is detected and classified whether the PCB board has a missing hole or not. The yellow marked areas are the missing holes detected parts.

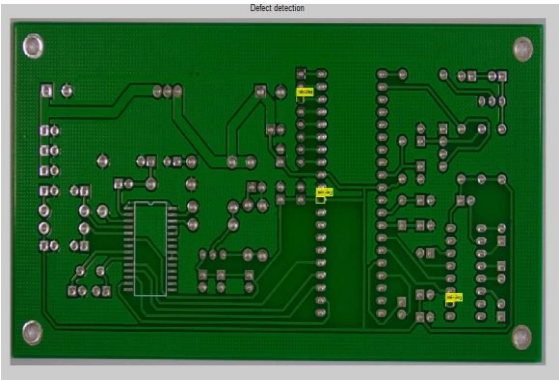

Fig 9 Missing hole

4. CONCLUSION

The defect is identified and separated by using image processing so in turn, it helps in mechanically supporting and connecting components along electric conductive tracks to electronic gadgets. It would also promote an Electronics shop, wholesale shop, and retrieval shop to buy whole products of non-defect PCBs. The leading objective is to know the quality of PCB whether it is defective or not.

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