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PCB Image Enhancement Using Machine Vision For Effective Defect Detection

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Abstract— *The primary objective of image enhancement is to process an image so that the result should be more suitable than the original image for specific applications. PCB image enhancement plays an important role in efficient defect detection. It is necessary to eliminate or minimize the noise as much as possible during image enhancement. This paper proposed an image enhancement algorithm based on machine vision to sharpen the edges of tracks in PCB and filter out the noise effectively. The proposed algorithm consists of Image acquisition, Color plane extraction, LUT transformation, Filtering, and Thresholding. Experimental results show that the proposed algorithm precisely locates edges of circuit tracks to enhance PCB images. The average time required to perform the proposed algorithm is 10 ms.*

Keywords- Machine vision, Color plane extraction, LUT transformation.

I. INTRODUCTION

PCB is the most important component of the electronic industry. So it is essential to detect defects during its manufacturing. Since the manual inspection is inefficient and time consuming, so automatic optical inspection is required.

Fig.1 shows the Printed circuit board image which is blurred over edge especially in the upper dense horizontal lines area. Therefore it is essential to eliminate or reduce noise to enhance the PCB image so that it can be visible at the edges. Literature 1 proposed the image enhancement algorithm for PCB defect detection based on Double sigmoid transformation method. This method enhance the PCB image be effectively sharpen edges. Also suppresses the noise associated with the image. Literature 2 lists the method of image enhancement about the common PCB. It mainly includes gray scale transformation, histogram equalization, average filter, median filter. Literature 3& 4 use HAAR wavelet transforms. In this transformation to highlight the details of the image, it is decomposed in the vertical and horizontal direction. But the pixel gray value of the digital image is non-continuous in all direction which might cause errors on the edges of the oblique line. This paper represents an algorithm consists of various steps, which has imposed on the original blurred PCB image along with the reduction of noise.

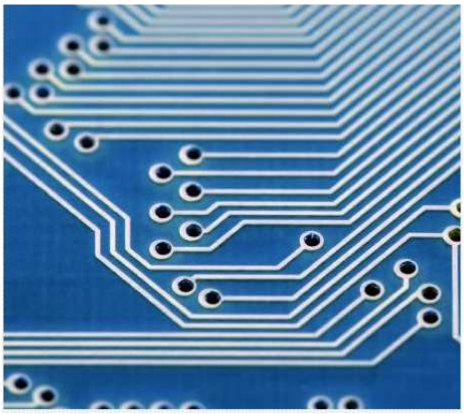


Fig.1 Blurred PCB image

II. ALGORITHM FOR IMAGE ENHANCEMENT

The algorithm for PCB enhancement is shown in flow chart (fig.2). It shows the different steps and methodology which is used for the enhancement process.

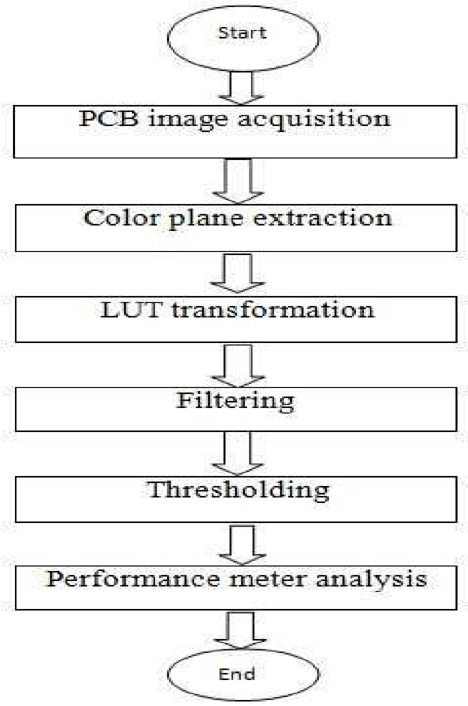


Fig.2 Algorithm for PCB image Enhancement

2.1 PCB acquisition:

Image browser contains all images currently loaded in vision assistant. The image acquired by using image acquisition. This paper acquired the PCB image as shown above in fig.1

2.2 Color planes extraction from RGB image:

The color planes extraction converts a RGB image into a gray scale image. Fig.3 shows the grayscale image of the blurred PCB image shown in fig.2.

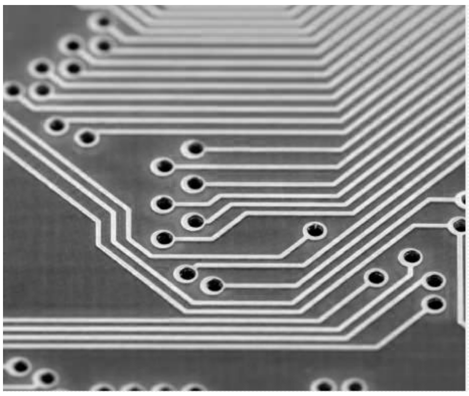


Fig.3 Grayscale image of blurred PCB image

A true color image is the 8 bit composition of three planes one from each red component, green component and blue component i.e. the color component intensity of a pixel are coded into a three different values.

The equation for conversion of RGB image to Gray scale image on pixel-by-pixel basis [5] is

$$\text{Grayscale value}=0.29R+0.58G+0.114B$$

2.3 LUT transformation:

LUT (look up table) transformation supports the image having binary /8 bit/ 16 bit / float format. It is used to improve the contrast and brightness of an image by modifying the dynamic intensity of regions with poor contrast. This transformation converts input gray level values from the source image into other gray level values in the transformed image.

A LUT transformation applies the transform T(x) over a specified input range [range min., range max.] in the following approach [6].

$T(x)$ = Dynamic min, if $X \le$ range min
F(x) if range min $< X \le$ range max
Dynamic max, if $X >$ range max

Where,

X represents the input gray-level value

Dynamic min = 0 (8-bit images) or the smallest initial pixel value (16-bit and floating point images)

Dynamic max = 255 (8-bit images) or the largest initial pixel value (16-bit and floating point images)

Dynamic Range = Dynamic max – Dynamic min

F (X) represents the new value.

After the execution of LUT transformation the the PCB image becomes shown in fig.4

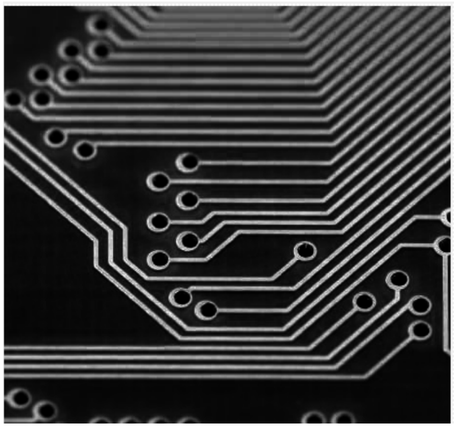


Fig.4 LUT transformed PCB image

2.4 Filtering:

Filtering is required for better extraction of the feature from PCB image. It extracts the information only needed from the image rather than processing the entire image to reduce processing time of the system. This step supports the image in the format of binary / 8 bit / 16 bit / float. Filtering works on the LUT transformed PCB image and the best result found with Convolution-highlight details having 7*7 kernel sizes. The filtered image shown in fig.5

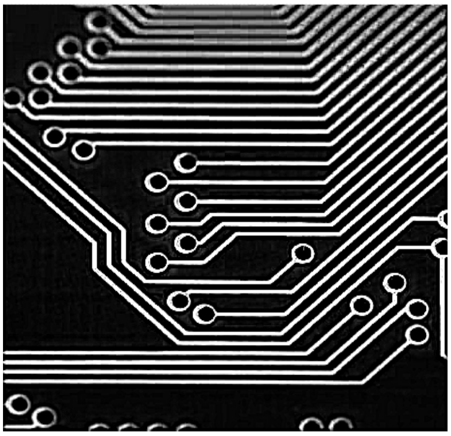


Fig.5 Filtered PCB image

2.5 Thresholding:

Thresholding is used for conversion of an image into binary image. This paper uses Manual thresholding method for converting the same. As shown in fig.6 red highlighted image contains required portion of image. The red portion represents '1' and rest of portion taken as '0' in the binary image. [6]

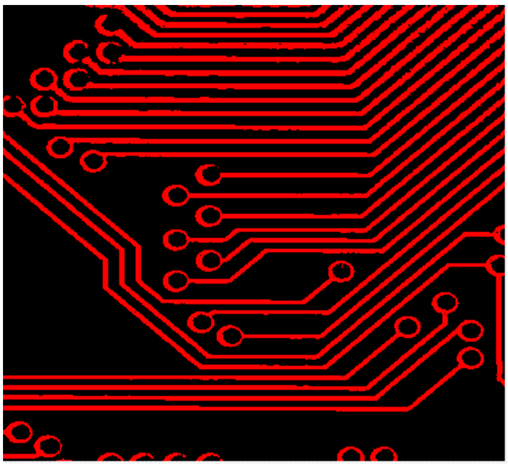
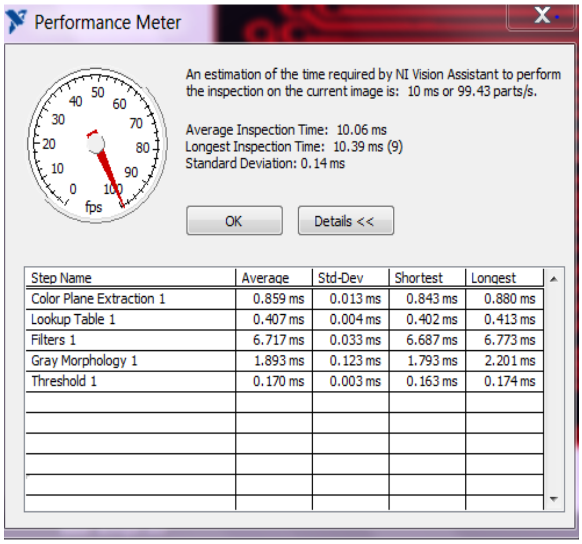


Fig.6 Image after thresholding

2.6 Performance analysis:

The response time is an important parameter which accounts for the processing speed of the system. In Vision Assistant there is a provision to measure the performance of the created script by measuring its response time. The detailed report of the performance of the script can also be obtained, this is shown in fig.7. In the detailed report the time taken by each step or each function for PCB image enhancement is given. The time required by NI Vision Assistant to perform the whole enhancement algorithm is 10 ms.



Step Name	Average	Std-Dev	Shortest	Longest
Color Plane Extraction 1	0.859 ms	0.013 ms	0.843 ms	0.880 ms
Lookup Table 1	0.407 ms	0.004 ms	0.402 ms	0.413 ms
Filters 1	6.717 ms	0.033 ms	6.687 ms	6.773 ms
Gray Morphology 1	1.893 ms	0.123 ms	1.793 ms	2.201 ms
Threshold 1	0.170 ms	0.003 ms	0.163 ms	0.174 ms

Fig.7 Performance analysis

III. CONCLUSION

This paper presents an image enhancement algorithm based on machine vision for PCB image enhancement. The captured PCB image is processed using Color plane extraction, LUT transformation, Filtering, and Thresholding with the help of National Instrument Vision assistant software. Experimental results show that the method can effectively sharpen edge tracks to enhance the PCB image. With the help of performance analysis it is noticeable that the time taken to execute the PCB enhancement algorithm is 10 ms or 99.43 parts inspected per second.

REFERENCES

[1] Shu-an Guan and Fenglin Guo, "A new image enhancement algorithm for PCB defect detection" International Conference on Intelligence Science and Information Engineering, 2011:454-456.

[2] Sun Xiaoting, Xiong Hongyun, "The preprocessing images in PCB Detection System" [J]. China information technology, 2007, 7:116-117.

[3] Zuwairie Ibrahim and Syed Abdul Rahman, "Wavelet based Printed Circuit Board inspection system" International Journal of signal processing 1, spring 2005: 73~69.

[4] Zhang Bo, Li Ruihua, Peng, Niancai etc, "The research of visual PCB defect inspection based of wavelet" Journal of system simulation, 2004, 16(8): 1864-1866.
[5] Sharat Chandra Bhardwaj,"Machine Vision algorithm for PCB Parameters Inspection" NCFAAIIA, 2012, Proceedings published by International Journal of Computer Applications® (IJCA), 20-24.
[6] NI Vision concept manual, 2009