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Mislaid-IC-Pin Detection Using 2-Dimensional Wavelets

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Abstract- Automation has made rapid industrial progress in the past few decades. To detect a broken pin of an IC (Integrated Circuit) connected to a PCB during manufacturing, the present day manual detection can be replaced by automated method based on image processing, which will make the process faster and easier. In this paper an accurate and fast automatic detection method is used where the top view camera shots of PCBs are processed using advanced methods of 2-dimensional discrete wavelet based edge detection. Comparison between conventional edge detection methods such as Sobel, Prewitt and Canny edge detection is also performed.

Index terms- 2-dimensional Wavelets, Edge detection, Sobel, Prewitt, Canny.

I. INTRODUCTION

In industrial automation, PCBs are made by line production techniques. The faulty IC pins on the mother board are difficult to identify during the production process unless it is fully automated. In this paper a novel method for detection of IC pins using wavelet based edge detection is proposed. The results are compared with some conventional methods used. A series of steps in wavelet based edge detection are performed in a systematic way which detects the faulty pins coming in the belt. Edge is a separation or a boundary between two homogeneous surfaces. Edge detection is almost a prerequisite in various tasks, especially in the manufacturing industries, where series of PCBs are tested. To check for a broken IC in a PCB, edge detection is the first step before image segmentation and classification. Fig.1 shows the image of an IC which was used for edge detection in the present investigation. Few conventional methods are Sobel, Prewitt and Canny edge detection. Various conventional techniques for edge detection of IC's are available in literature. [2] proposes an improved algorithm for canny edge detection. It uses an improved switch median filter algorithm instead of Gaussian filter algorithms for filtering. [1] used wavelet transforms to compress the image before edge detection.

In the present investigation, firstly the edge detected results were analysed without using wavelet transform and in the second the edge detected results were analysed after using wavelet transform. The success of the method is derived based upon how efficiently the edges have been detected.

II. EDGE DETECTION

An edge is an abrupt change in the intensity level, which characterizes high frequency component in an image. Noise is an unwanted signal which can cause inefficiency in edge detection. The wavelet transform is an effective tool which can be used before edge detection. The purpose of using wavelet transform is to remove low frequency component and use only the high frequency components. In practice due to imperfection in image acquisition or sampling, the edges get blurred and tend to become thick. However the derivatives play an important role in detecting the edges and locating the edge pixels in an image. The first derivative is positive at the point of intensity variation and zero in the areas of constant intensity. The magnitude of first derivative can be used to detect the presence of an edge. The second derivative is positive if the transition occurs on the dark side of an edge and it is negative if transition is on the light side of an image. Hence, a second derivative can be used to locate the edge pixels. For edge detection second derivative can also be used but its sensitivity towards noise limits its application in edge detection. In the subsequent sections we will be discussing about the approximated first derivative operators that are used for edge detection in the present investigation.

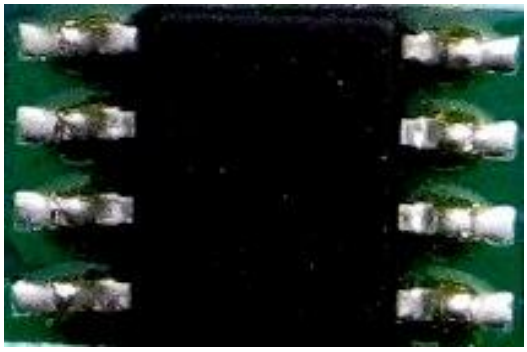


Fig.1 Image of an IC used for edge detection

III. EDGE DETECTION METHODS

A. SOBEL-

The Sobel edge detector is an approximated, first derivative two dimensional edge detector. It calculates gradient in X and Y direction. It uses a convolutional mask to calculate the gradients as in (1) and gradient directions as in (2) in X and Y directions. The masks are slid over the image and gradient values are calculated. In Sobel the center coefficient of the mask uses a weight of two, it is used so as to achieve a smoothing by giving more weightage to the central term of the mask. The Image obtained by using a Sobel operator is shown in Fig. 2 (a)

$$|G| = |G_x| + |G_y| \quad (1)$$

$$\theta = tan^{-1}[G_y/G_x] \quad (2)$$

B. PREWITT-

Prewitt edge detector is also an approximated first derivative two dimensional edge detector. It uses a convolutional mask to calculate the gradient in X and Y directions respectively. The Image obtained by using Prewitt operator is shown in Fig. 2 (b)

C. CANNY-

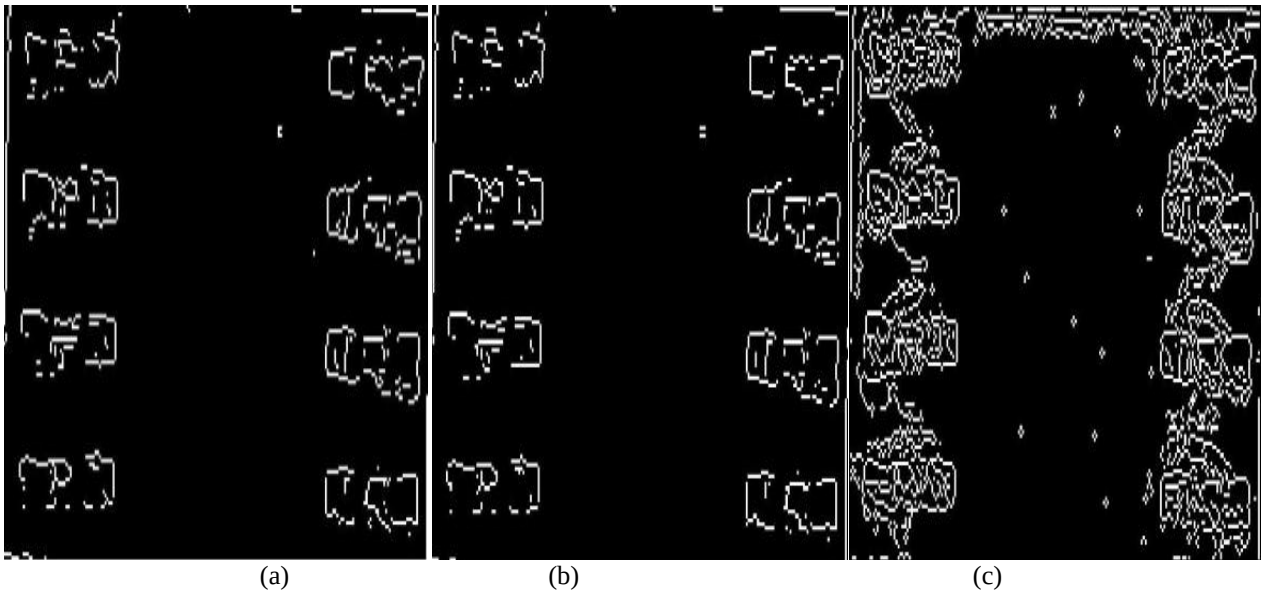
Canny edge detection is another method of edge detection. It follows a series of steps. In the first step it eliminates the noise from the Image by filtering the Image using Gaussian filter. In the second step it calculates the gradient $|G|$ and the edge direction θ of the Image using Sobel edge detection. In the third step it performs non-maximum suppression. The pixels along the edge direction which do not satisfy (3) are set to 0 or considered as non-edge pixel. Further suppression is done using hysteresis. Hysteresis uses two thresholds. T1 and T2. If the magnitude is below the first threshold then it is set to 0 (non-edge pixel). If the magnitude is above threshold T2 then it is considered as an edge pixel. If the magnitude lies between T1 and T2 then depending upon the path between the current pixel and the pixel with magnitude greater than T2 the pixel is considered as an edge pixel or non-edge pixel. The Image obtained by using a canny edge detector is shown in Fig. 2 (c).

$$G_T = \begin{cases} G & if\ G > T \\ 0 & otherwise \end{cases} \quad (3)$$

D. WAVELETS-

Wavelets are the small portion of the wave. Wavelet transform uses wavelets to capture different frequency components of the signal whose resolution matches up with its scale. This technique is known as Multiresolution Analysis. It comprises of a scaling function and a wavelet function. Scaling function gives the series of approximation of the signal, where each approximated signal differs by a factor of two. Wavelet functions are used to add the detailed information in the difference of the two neighbouring approximations. Hence in wavelet analysis we get the approximated part and the detailed part of the signal.

In case of Images the wavelet analysis is carried out in two dimensions. In X and Y direction respectively. The two dimensional wavelet decomposition is shown in the form of block diagram in fig. 3.It is known as filter bank analysis. It consists of high pass and low pass filters. First the analysis is done along the columns (along n) and then along the rows (along m). The output of the low pass filter gives the approximated coefficients and the output of the high pass filter gives detailed coefficients. The approximated coefficients at scale j+1 are used to construct the detailed and approximated coefficients at scale j. In case of two dimensions we get three sets of detailed coefficients and one set of approximated coefficient.



(a) (b) (c)

Fig.2 (a) is sobel edge detected image without using DWT (b) is prewitt edge detected image without using DWT (c) is canny edge detected image without using DWT

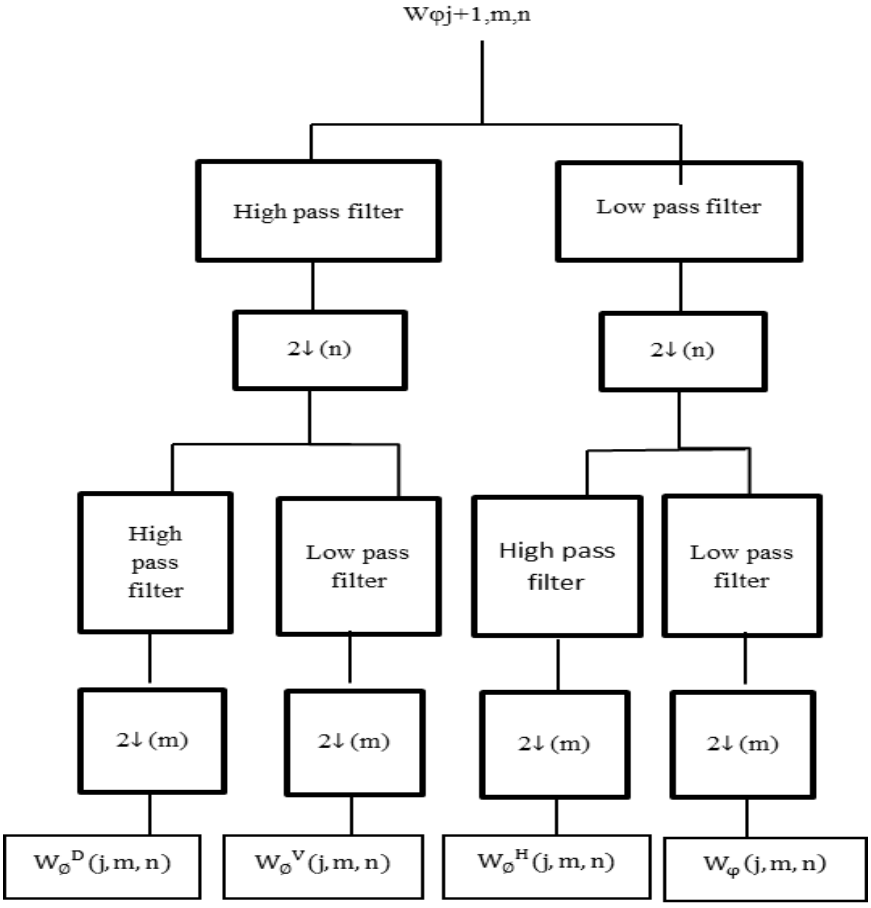


Fig. 3 Block diagram of 2D wavelet decomposition

IV. METHOD PROPOSED-

In our paper an efficient technique for edge detection is proposed. Edge detection was first carried out without using wavelet transform. Sobel, Prewitt and canny edge detectors were used. The result of Sobel, Prewitt and canny edge detectors is shown in fig. 2. In the next part the edge detection was performed after using wavelet transform. Wavelet transform was used to filter out the image. The wavelet transform gave one set of approximated coefficients and three sets of detailed coefficients. The approximation coefficient was eliminated and the image was reconstructed using the three sets of detailed coefficients. The result of reconstructed Image is shown in Fig. 4(a). On the reconstructed Image Canny edge detection was applied. The result of canny edge detection on reconstructed Image is shown in Fig. 4(b). Fig. 5 shows the block diagram of the methodology used for edge detection.

(a) (b)

Fig. 4 (a) Reconstructed Image using high frequency components (b) Canny edge detected image after using DWT

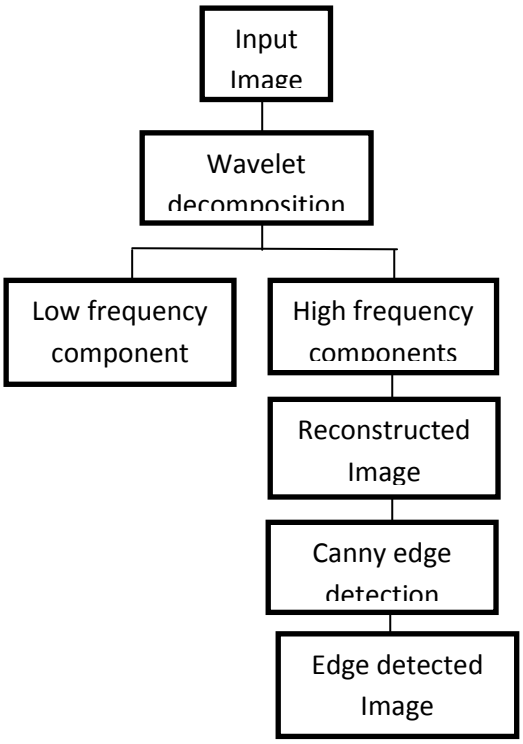


Fig. 5 Block diagram of the methodology used for edge detection.

V. COMPARISON BETWEEN THE METHODS OF EDGE DETECTION-

Image segmentation was performed on the edge detected images. The segmented images are shown in Fig. 6. To determine the usefulness of wavelet transform before edge detection the pins of actual image was cropped and the uncropped part of the image was made to 0.The cropped image was then multiplied with segmented images obtained after edge detection. The number of pixels was then counted and the results were compared.

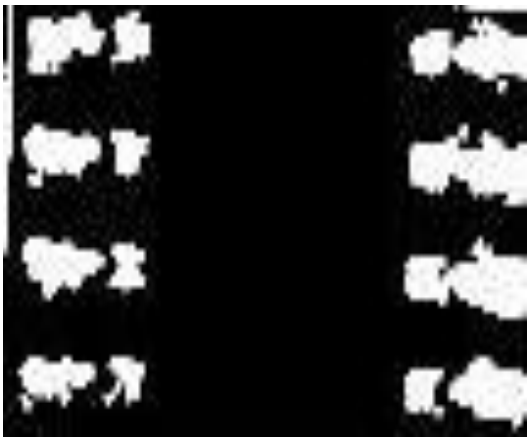


Fig.6 Segmented Image

VI. RESULTS-

To determine the efficiency of the discrete wavelet transform number of pin pixels were counted using adobe Photoshop and MATLAB. The count for the number of pin pixels of actual image, edge detected image using sobel, prewitt, canny and canny edge detection after using discrete wavelet transform were shown in table I. The efficiency for sobel, prewitt and canny edge detection was 30.36%, 34.33% and 54.58%. Whereas, the efficiency of canny edge detection after using discrete wavelet transform was 84.25%. Fig.7 shows the comparison between different techniques for edge detection.

VII. CONCLUSION-

The results lead to the conclusion that the use of discrete wavelet transform before edge detection improved the efficiency of edge detection. Among sobel, prewitt and canny, canny edge detector should be used for edge detection.

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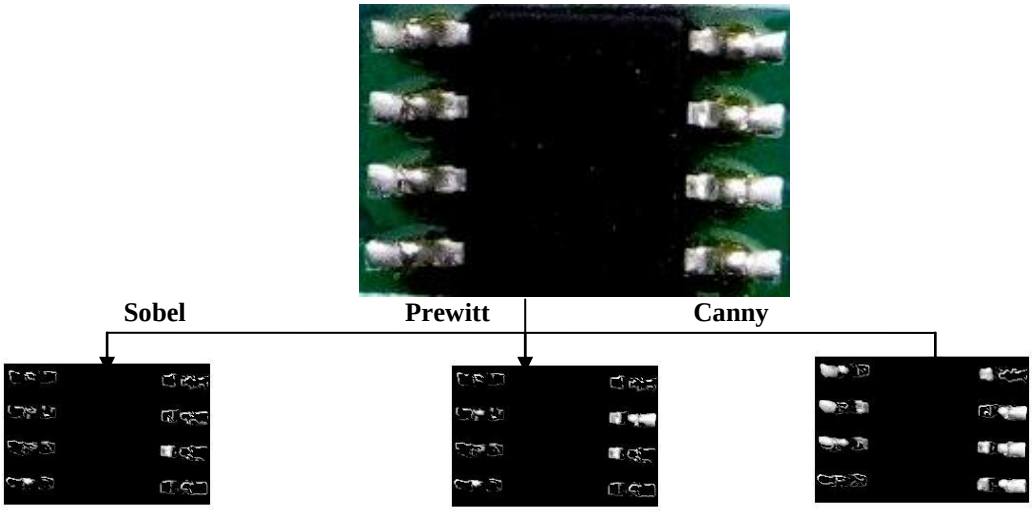
TABLE I shows the pixel counts

ACTUAL IMAGE	SOBEL	PREWITT	CANNY	DWT + CANNY
6689	2031	2297	3651	5636



Pin Pixels detected:2031/6689 Pin pixels detected:2297/6689 Pin Pixels detected: 3651/6689

Fig. 7 Comparison of Sobel, Prewitt and Canny edge-detection techniques

REFERENCES-

[1] K. Somyot, S. Anakapon and K. Anantawat, *"Pattern recognition technique for IC pins inspection using wavelet transform with chain code discrete Fourier Transform and signal correlation",* International Journal of Physical Sciences, Vol.7 (9), pp. 1326-1332, 23 February 2012.

[2] Ying Huang,Qi Pan,Qi Liu,Xin Peng He,Yun Feng Liu,Yong Quan Yu, *"Application of Improved Canny Algorithm on the IC Chip pin Inspection",*Advanced Materials Research Vols. 317-319 (2011) pp 854-858.

[3] A.W. Galli, G.T. Heydt and P.F. Ribeiro, *"Exploring the power of Wavelet Analysis",* IEEE Computer Applications in Power, October 1996.

[4] Pai Hui Hsu and Peng Gong, *"Spectral feature extraction of Hyperspectral Images using Wavelet Transform",* Journal of photogrammetry and remote sensing, Volume 11, No. 1, March 2006.

[5] Tim Edwards, *"Discrete Wavelet Transform: Implementation and theory",* Stanford University, September 1991.

