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Mislaid character analysis using 2-dimensional discrete wavelet transform for edge refinement

Kushal Kumar[1], Anamika Yadav[2], Himanshi Rani[3], Yashasvi Nijhawan[4]
[1](Electronics and Communication Engineering, Jaypee University of Engineering and Technology, India, 2013)
[2](Electronics and Communication Engineering, Bhagwan Parshuram Institute of Technology, GGSIPU, Delhi, India, 2012)
[3](Electronics and Communication Engineering, Vellore Institute of Technology, Chennai, India, 2015)
[4](Electronics and Communication, Jaypee University of Information Technology, Waknaghat, India, 2013)

ABSTRACT: *Character recognition is an important tool used for many purposes limited only by imagination, some of them being automatic number plate recognition and digital conversion of texts. In the present methods, edge detection techniques perform well but they are time consuming and have errors if the data provided is not up to the mark. In this paper, a novel method is proposed to minimize those errors and perform the edge detection of characters using 2-dimensional wavelet transform pre-processing.*

Keywords: *2-dimensional wavelets, Character recognition, Machine vision, Image processing, ANPR.*

I. INTRODUCTION

Today, many character recognition systems are used worldwide. The system works fine too in most of the cases, but sometimes the characters on given image aredifficult to identify because of many reasons like bad lightning, or mislaid/broken characters. In this paper, a vehicle number plate with difficult to detect characters is taken and, a novel image processing method for detection of characters using wavelet pre-processing is proposed to segment the characters from that image. The criterion used to compare different methods is touse the number of pixels of the characters the method could detect with the conventional edge detection techniques to emphasize the benefit of 2D-DWT over those methods.

A series of steps in wavelet pre-processed edge detection are performed in a systematic way which detects the characters. Edge detection is almost a prerequisite in various recognition tasks, like automatic number plate recognition, which we have done in this paper. Edge is a boundary between two homogeneous surfaces. Fig.1 shows the text which was used for edge detection in the proposed method and the conventional edge-detection methods (Sobel, Prewitt and Canny). Various conventional techniques for edge detection of IC's are available in literature[1]. Huang et al. (2011) proposes an improved algorithm for canny edge detection. It uses an improved switch median filter algorithm instead of Gaussian filter algorithms for filtering. [2]Somyot et al.(2012) used wavelet transforms to compress the image before edge detection.

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.

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.

III. CONVENTIONAL EDGE DETECTION METHODS

The edge detection methods used in this paper are Sobel, Prewitt and Canny, which are compared to each other and then the best one of them is compared to the proposed algorithm. The algorithms are compared based on how much amount of the character data can they extract from the given image. So, first we should know briefly what these methods are and how do they work. Next, we extract the pin information from the original image as well as segmented edge-detected image in the form of number of pin-pixels and compare which method extracts the maximum pin-information for analysis. In the original image, the no. of pixels contained by the characters are 1882.

3.1 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 equation (1) and gradient directions as in equation (2). The masks are slid over the image and gradient values are calculated. In Sobel the centre 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 segmented image obtained by using a Sobel operator is shown in Fig.2. The number of pin-pixels detected by this algorithm was 203.

$$|G|=|G_X|+|G_Y| \qquad (1)$$

$$\Theta=\tan^{-1}\left[\frac{G_Y}{G_X}\right] \qquad (2)$$

3.2 PREWITT

Prewitt edge detector is also an approximated first derivative two dimensional edge detector. It uses aconvolutional mask to calculate the gradient in X and Y directions respectively. The segmented image obtained by using Prewitt operator is shown in Fig.3. The number of pin-pixels detected by this algorithm was 201.

3.3 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 and the edge direction 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 segmented image obtained by using a canny edge detector is shown in Fig.4. The number of pin-pixels detected by this algorithm was 978.

IV. WAVELETS

Wavelets are a 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 multi-resolution 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 an image in Fig. 5. It is known as filter bank analysis. It consists of high pass and low pass filters. First the analysis is done along the columns and then along the rows. 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 (rest three squares) and one set of approximated coefficient (upper left square).

V. PROPOSED METHOD

In the proposed method, we have first subjected the image to a 2-Dimensional discrete wavelet transform (2-D DWT). Doing this, we get a set of 4 images, one is the set of approximated coefficients and the other three are set of detailed coefficients. We ignore the approximated coefficient and reconstruct the image using the set of detailed coefficients, i.e. we take inverse 2-D DWT. The image is now ready to be edge-detected using any conventional algorithm like Canny in this case. So, we choose the best one of the conventional methods, which comes out to be Canny and then compare it with our proposed method in Fig. 6. The number of pin-pixels detected by this algorithm was 5636, i.e. 84.25% of the pin-information is accurately extracted.

VI. FIGURES

Fig.1 Original IC image.

Fig.2Character segmentation on Sobel edge-detected image.

Fig.3 Pin segmentation on Prewitt edge-detected image

Fig.4 Character segmentation on Canny edge-detected image.

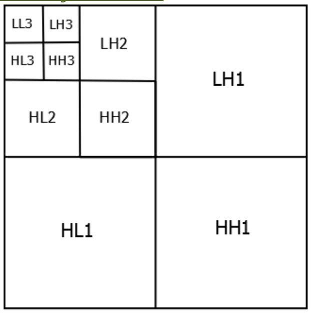

Fig.5 2-D DWT illustration.

Fig.6 Pin segmentation on Wavelet pre-processed Canny edge-detected image.

VII. CONCLUSION

Based on the results the following inferences can be made. When wavelet pre-processing was not performed, canny edge detection, Fig.4 was found to be the most efficient method followed by Sobel, Fig.2 and Prewitt, Fig.3, which are pretty close to each other. When wavelet pre-processing was used, the results obtained are as shown in Fig. 6 which arefar more accurate than the results obtained without using wavelet pre-processing as in Fig. 2, 3 and 4. The proposed method detects over 50% of the pixels while the conventional methods could detect only about 10%. On using wavelet pre-processing the low frequency component of the image was removed and high frequency components were retained during reconstruction. The edges which comprises of high frequencies were efficiently detected. Thus the choice of using wavelet pre-processing made edge detection more efficient. Better and efficient extraction of IC pin information was achieved.

Many sectors could benefit from this approach, like the traffic regulation sector or the handwriting analysis sector. The number of man-hours will be greatly reduced and the results would be more accurate than any of the current methods. This method could be implemented over existing hardware.

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