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A Novel Technique for Image Enhancement Based On Image Pixel Interdependency Linear Perceptron Network

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Abstract: Image enhancement is one of the challenging issues in low level image processing. Various authors proposed various methods such as histogram equalization, multipoint histogram equalizations and pixel dependent contrast preserving, but all these method are not up to marks. Now we proposed a new technique for image enhancement based on curvelet transform and perceptron network. Through curvelet image transform into multi-resolution mode. Then find the pixel difference for the dependency of contrast, this difference matrix work as a weight vector for perceptron network.

Keywords: multipoint histogram equalization, curvelet, perceptron network, image enhancement, histogram equatization.

I. INTRODUCTION

In digital image processing, image enhancement technique is used to improve the quality of input image by which the output image looks better than the original image. In image enhancement one or more attributes of image are enhanced. Basically image enhancement is done in spatial domain and transform domain. In spatial domain technique [1] we directly deal with image's pixel, that means in spatial domain the intensity value of pixels are manipulated, whereas in transform domain [2] all enhancement operations are done on transform domain coefficients then the inverse transform is performed to get Resultant image.

Histogram equalization [3] is very popular technique for enhancing the contrast of an image, which distributes pixels value uniformly such that the output image has linear cumulative histogram. Contrast can be defined as a ratio of maximum intensity to minimum intensity. The main idea of HE-based methods is to re-assign the intensity values of pixels to make the intensity distribution uniformly. However, sometimes it also degenerate the result which is often called as washed out effect. Histogram equalization technique enhances the contrast of an image but it tends to change the brightness of image that means it does not preserve the brightness of image, because HE technique is a global operation. To overcome the drawback that are introduced by the HE method, such as a brightness preserving Bi-HE (BBHE) method was proposed in [4].

Dualistic sub-image histogram equalization (DSIHE) [5], Minimum Mean Brightness Error Bi-HE (MMBEBHE) [6] ,Recursive mean separate HE(RMSHE) [7] , Multi-histogram equalization (MHE) [8] . Now we proposed a new technique for image enhancement based on curvelet transform and perceptron network. Through curvelet image transform into multi-resolution mode. Then find the pixel difference for the dependency of contrast, this difference matrix work as a weight vector for perceptron network.

II. PREVIOUS WORKS

This section describes some previous works in the literature which make use of the HE method with the purpose of image enhancement.

By Y.T. Kim, "Contrast enhancement using brightness preserving bi-histogram equalization," (BBHE) [4], is proposed. The BBHE method decomposes the original image into two sub-images, by using the image mean gray level, and then applies the HE method on each of the sub images independently, that means by this we obtain two histograms such that one contains high intensity pixels and another contains low intensity pixels. At some extent BBHE preserves brightness of image; however generated image might not have a natural appearance.

By Fan Yang, Jin Wu [9], to enhance image contrast presents an improved image contrast enhancement based on histogram equalization, which is especially suitable for multiple-peak images. Firstly, the input image is convolved by a Gaussian filter with optimum parameters. Secondly, the original histogram can be divided into different areas by the valley values of the image histogram. Thirdly, using of proposed method processes images. This method outperforms others on the aspects of simplicity and adaptability.

BY P. Rajavel [10], proposes image-dependent brightness preserving histogram equalization (IDBPHE) technique to enhance image contrast while preserving image brightness. The proposed image dependent brightness preserving histogram equalization (IDBPHE) technique use

the wrapping discrete curvelet transforms (WDCvT) and the histogram matching technique. A simple diagram of IDBPHE is shown in Fig. 1 and the corresponding steps are given below.

a. Region identification and separation: The curvelet transform is used to identify bright regions of an original image.
b. Histogram computation and matching:
i. A histogram of the original image and the histogram of pixels which belong to the identified regions are computed.
ii. Modify a histogram of the original image with respect to a histogram of the identified regions.

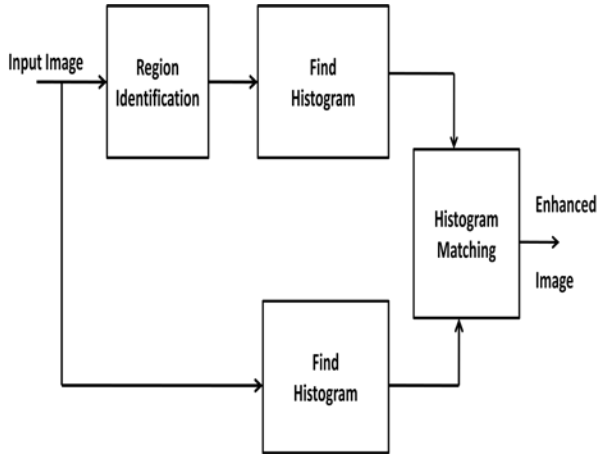


Figure. 1. Image enhancement

By S.D. Chen and A. Ramli, "Minimum mean brightness error bi-histogram equalization in contrast enhancement," Minimum Mean Brightness Error Bi-HE (MMBEBHE) [6] is an extension of the BBHE method. In MMBEBHE the separation intensity is minimum mean brightness error between input image and output image. The separation intensity is used to divide the histogram into two sub histogram and then applies the HE on each sub histogram independently.

III. IMAGE PIXEL INTERDEPENDENCY LINEAR PERCEPTRON NETWORK

The proposed Image Pixel Interdependency Linear Perceptron Network (IPILN) technique uses Gaussian filter, curvelet transform and perceptron network. Basically our proposed technique involves three steps that are below.

a) Image Filteration: The Gaussian filter is used to obtain a row image from input image.
b) Image Transformation: To transform the row image, the curvelet transform is used that is a multidirectional transform.
c) Perceptron Network: To adjust the weight of input image, the concept of perceptron network is used.

A. Image Filtration

The image filtration is a pre-processing step in image enhancement that reduces the noise from input image and obtains a row image .The pre-processing for image filtration is shown in fig. 2

Figure. 2 Image Filtration

In this work Gaussian filter is used to reduce the noise interference from input image. Gaussian filter is calculated by using the following equation [1]:

$$G(i,j) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{i^2 + j^2}{2\sigma^2}\right) \qquad (1)$$

Where σ is the standard deviation in the area of mask size, (i, j) are the coordinates relative to the center of the filter.

B. Image Transformation

To transform a row image into multi-resolution mode, the curvelet transform function is used. It enables directional analysis of images in different scales. The curvelet transform, like the wavelet transform, is a multi-scale transform, with frame elements indexed by scale and location parameters. Unlike the wavelet transform, it has directional parameters, and the curvelet pyramid contains elements with a very high degree of directional specificity. The overall process of image transformation is shown in fig. 3.

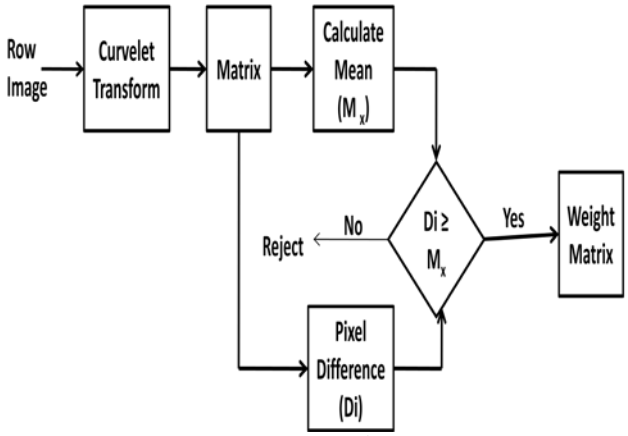


Figure. 3 image transformation

Image transformation is done in many steps that are as follows.

a. Row image is converted in a matrix form by using the curvelet transform that is a multi- directional transform.
b. Calculate the mean value of matrix and the mean value are used as a threshold value. The mean value is calculated by equation 2:

$$M_x = \sum_{i=0}^{m} \frac{x_i}{n} \qquad (2)$$

c. Calculate the pixel difference by using gradient decent method. The gradient decent is based on minimization of error E defined in terms of weight and activation function of network.
d. Compare the pixel difference with mean value .If pixel difference is grater than mean vale then, pixel difference value is selected for weight matrix, otherwise is rejected.

C. Perceptron Network

The perceptron model comprise three units, the sensory unit S, association unit A and response unit R that are shown in fig. 4

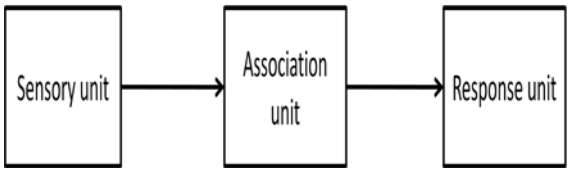


Fig. 4 Perceptron model

The unit S includes 400 photo detectors that receives input image and provides a 0 or 1 electric signal as output. If the signal exceed a threshold, then the photo detectors outputs 1 else 0. The unit A comprises feature demons or predicates. The predicates examine the output of S for specific features of image. The third unit R comprises pattern recognizer or perceptrons which receives results of predicates; also in binary form.The training algorithm of perceptron is supervised learning algorithm where weights are adjusted to minimize error whenever the computed output does not match the target output. A multilayer feed forward perceptron model is shown in fig. 5, where X is the input, $w_{I\,j}$ is weight from I to j and Y is output.

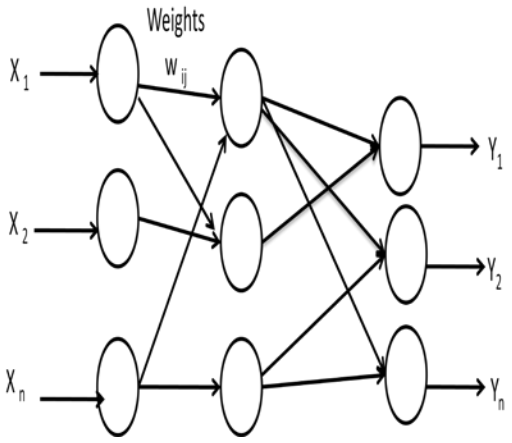


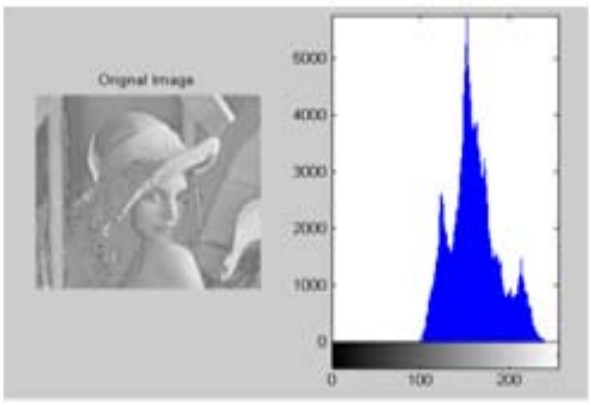
Figure. 5 Multilayer feed forward perceptron

A basic learning algorithm for training the perceptron is as follows:

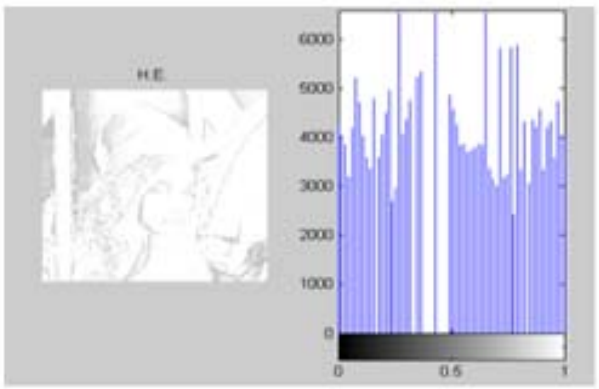
a. If output is correct, No adjustment of weight is done.
   i.e $W^{(k+1)}{}_{ij} = w^{k}{}_{ij}$ (3)
b. If output is 1 but should have been 0 then weights are decreased on active input links.
   i.e $W^{(k+1)}{}_{ij} = w^{k}{}_{ij} - \alpha.x_i$ (4)
c. If output is 0 but should have been 1 then weights are increased on active input links.
   i.e $W^{(k+1)}{}_{ij} = w^{k}{}_{ij} + \alpha.x_i$ (5)

IV. EXPERIMENTAL RESULT

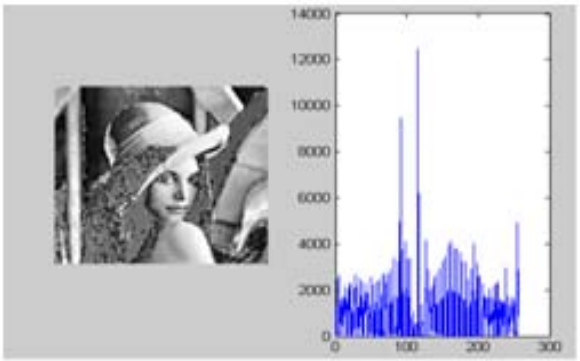
Our proposed method for contrast enhancement has applied on several images and we have compared the result of our method with other image enhancement methods such as histogram equalization, multi-histogram equalization and IDBPHE. To evaluate the effectiveness of our proposed method, we have used the AMBE and PSNR. By comparing the AMBE and PSNR of our proposed method with HE, MHE and IDBPHE, mathematically we have proved that our method is better than other methods .Fig.6 shows the example of using HE, MHE, IDBPHE and proposed algorithm on Lena image.



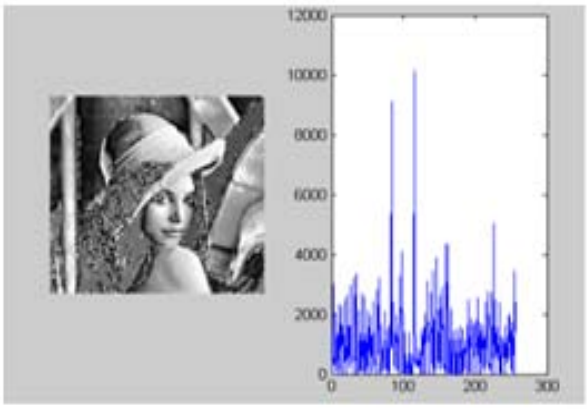
(a) Lena image



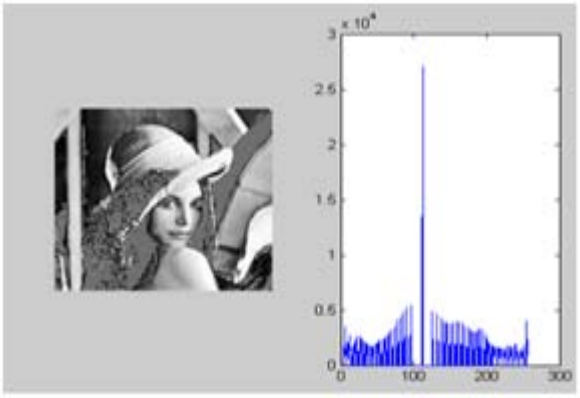
(b) HE



(c) MHE



(d) IDBPHE



(e) Proposed Method

Figure. 6 Lena image comparing HE, MHE, IDBPHE and Proposed method

Fig. 6 (a) is the original image, Fig. 6(b) shows the performance of HE in which the brightness is improved but contrast is reduced. Fig 6(c), Fig. 6(d) and Fig. 6(e) show the performance of MHE, IDBPHE and proposed method. We are comparing the result of our proposed method in terms of AMBE and PSNR that is shown in Table 1.

Table .1

Methods	**mage(Lena)**	
	AMBE	**PSNR**
HE	37.7184	10.8261
MHE	36.4263	12.1085
IDBPHE	22.0842	12.9922
Proposed	9.2784	23.6377

Absolute mean brightness error (AMBE) is used to asses the degree of brightness preservation. Smaller AMBE is better. AMBE is calculated by

$$AMBE = (X, Y) = M_x - M_y$$

Where $M_x$the mean of input is image and M_y is the mean of output image.

Peak signal to noise ratio (PSNR) is used to asses the degree of contrast enhancement, greater PSNR is better. PSNR is calculated by

$$PSNR = 20\ log\ \left(\frac{I_{max}}{\sqrt{MSE}}\right)$$

Our proposed method has given smaller AMBE and greater PSNR as compare to other methods.

V. CONCLUSION

This paper, proposed a novel image enhancement technique “image pixel interdependency linear perceptron network (IPILP).IPILP uses the curvelet and perceptron network for image enhancement. The curvelet transform is used to transform an image into multi-resolution mode and perceptron network is used to adjust the weight of input image or values. Our proposed method for contrast enhancement has applied on several images and we have compared the result of our method with other image enhancement methods .To evaluate the effectiveness of our proposed method, we have used the AMBE and PSNR. By comparing the AMBE and PSNR of our proposed method with HE, MHE and IDBPHE, mathematically we have proved that our method is better than other methods.

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