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Image Contrast Enhancment Using Feed Forward Network

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Abstract: **Histogram Equalization (HE) is a popular, simple, fast and effective technique for improving the gray image quality. Contrast enhancement was very popular method but it was not able to preserve the brightness of image. Image Dependent Brightness Preserving Histogram Equalization (IDBPHE) technique improve the contrast as well as preserve the brightness of a gray image. Image features Peak Signal to Noise Ratio (PSNR) and Absolute Mean Brightness Error (AMBE) are the parameters to measure the improvement in a gray image after applying the algorithm. Unsupervised learning algorithm is an important method to extract the features of neural network. We propose an algorithm in which we extract the features of an image by unsupervised learning. After apply unsupervised algorithm on the image the PSNR and AMBE features are improved**.

Keywords: histogram equalization; he; mhe; idbphe; pdf and cdf

I. INTORDUCTION

Digital image processing branch is dealing in the assessment, improvement, extraction and retrieval of features from a digital computer image. Visualization is the important key feature of human being by which we measure the quality of an image. Image processing involves some primitive operations such as sharpening image; reduce noise and contrast enhancement, image sharpening, image

segmentation (partitioning an image into sub regions or multiple objects). Aim behind all the image enhancement techniques is to improve the quality of the input image. Simplest image enhancement technique to improve the image contrast is Histogram Equalization (HE) [1].

Histogram Equalization is based on the uniform distribution of the image pixels. In HE method the mean of image pixel distribution is identified and the pixel distance is improved based on the basis of the difference between pixel and mean. Goal of HE method is to improve the pixel distribution in the input image after processing. The HE technique is a global operation hence; it does not preserve the image brightness. To improve the histogram technique we Sub division of image histogram and then perform the operations. Brightness preserving bi-histogram equalization (BBHE) [2] and dualistic sub-image histogram equalization (DSIHE) [3] techniques do histogram equalization by sub divide the input image as well as sub divide the histogram. Multi Histogram Equalization (Multi-HE) [4] improves the subdivision method used by BBHE and DSIHE. In Multi-HE method we sub divide the input image into several sub-images, and then applying the HE method on the sub divided input image.

A cost function is also used for automatically deciding in how many sub-images the input image will be decomposed on. By observing the value of brightness in the original and the processed images (i.e, the brightness preservation), we state that: 1) The images produced by Multi-HE are better in preserving the brightness of the original images; 2) Even thought Multi-HE are not always the best brightness preserving ones, their resulting brightness is always very close to the brightness of the original images.

In order to enhance contrast, brightness and produce natural looking image, this article propose a Multi -Layer Feed-Forward Image Enhancement Filter (MLFFIEF). In MLFFIEF we first decompose the input image into several sub-images. The curvelet transform, histogram matching technique with Feed Forward Network is used. The proposed MLFFIEF method undergoes two steps. (i) Region identification using the curvelet transforms. (ii) Training of image pixels using Feed Forward ANN (iii) Computation of a histogram of original image pixels and image pixels after training (iv) Modification of a image histogram with respect to a histogram of the identified region. This paper is organized in sections.

II. RELATED WORK

A. *Histogram Equalization*

Mainly, image contrast enhancement methods can be classified into two sub categories: global and local methods. In this research work, the multi-peak generalized histogram equalization (multi-peak GHE) is proposed for improving the image contrast. In this proposed work, the global histogram equalization is combined with local information of the image and the contrast is improved by using multi-peak histogram equalization. In the experiments, we employed different local information with the image. This method adopts the traits of existing methods which was working on histogram based method. It also improves the degree of the enhancement completely controllable which was a problem in the existing histogram method. Experimental results with the different images show that it is very effective in enhancing images with low contrast, without focusing on the brightness of the image. If we need the proper features of local information from an image, proposed technique Multi-peak GHE technique is very effective and powerful.

B. *Multihistogram Equalization*

They propose a technique which was the improvement of histogram enhancement which is called Multi-Histogram Equalization or Multi-HE. In this method the original image or input image is decomposing into several sub-images, and then applying the classical HE process to each one. Proposed method perform the image contrast enhancement in such a way so the final image will look more natural due to the preserving the brightness. They propose two special functions for image decomposing. To decide how many decomposition of an input image will have this method use a cost. By performing Experiments on various images we evaluate that this method preserve more the brightness and produce more natural looking images than the other existing HE methods.

C. *Multiple-Peak Histogram Equalization*

To solve the two fundamental problems of Histogram Equalization, this method presents an improved image contrast enhancement based on histogram equalization. This method is especially suitable for images which have multiple-peak as its characteristics. In the first step we apply the Gaussian filter one input image with optimum parameters. In the second step, the original histogram can be divided into different areas on the basis of the valley values of the image histogram. In the next step, by using of proposed method we process the images. This method is powerful on the basis of simplicity and adaptability. Experiment results of this method shows that the proposed algorithm has good performance in the field of image enhancement.

D. *Image Dependent Brightness Preseving Histogram Equalization*

In this proposed work he proposes a technique which preserves the image brightness after the enhancement of contrast of an image without creating unwanted artifacts. Proposed method uses the curvelet transform and histogram matching technique to enhance the contrast and preserve the brightness of original image. The proposed Image Dependent Brightness Preserving Histogram Equalization (IDBPHE) technique is having the two following steps. (i) To identify the bright regions of original image or input image this technique use curvelet transform. (ii) With respect to the identified regions the histogram of the original image is modified. Proposed method enhances the contrast and also preserves the brightness without any undesirable artifacts because the histogram of the original image is modified using a histogram of portion of the same image. Experiment results are performed on the images and evaluate the results which were satisfactory and show the improvement in the previous histogram method. Effectiveness of this method is evaluated on the basis of two important parameters for a gray image, Absolute mean brightness error (AMBE) and peak signal to noise ratio (PSNR).

III. PROPOSED WORK

The proposed Multi Layer Feed Forward Image Enhancement Filter (MLFFIEF) technique use the curvelet transforms, and Feed Forward Network of Artificial Neural Network and histogram matching technique.

A. Curvelet Transform

Curvelet transform [7] is the modified form of wavlet transform. It is specially used for image analysis. It helps for curve shapes analysis . It is developed by Candes and Donohol in 2000 [Candes and Donoho 2000]. Curvelet transform has a highly redundant dictionary which helps to provide sparse representation of signals that are not having regular shape. It works on the uneven shapes which has regular curve. Curvelet transform was improved later and was re-introduced as Fast Digital Curvelet Transform (FDCT) [Candes et al. 2006]. Improved second generation curvelet transform is designed to make is simpler to understand and easy to use. It is also faster and less redundant compared to its first generation version. For both type of signals continuous or discrete, Curvelet transform gives better results. Since image-based feature extraction requires only 2D FDCT, we are using it in our proposed work.

To implement the curvelet transform in our proposed work, first we take 2D Fast Fourier Transform (FFT) of the image. After that the 2D Fourier frequency plane is divided into wedges (like the shaded region in figure 1). Result of partitioning the Fourier plane into radial (concentric circles) and angular divisions is the parabolic shape as represented in figure 1.

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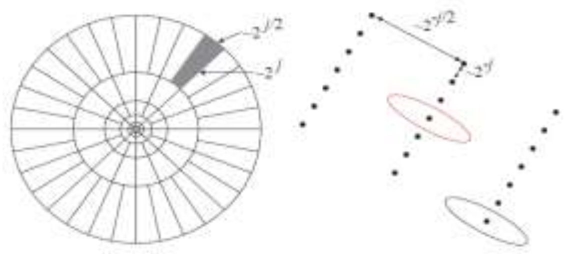

Figure 1: Curvelets in Fourier frequency (left) and spatial domain (right) [Candes et al. 2006].

Decomposition of image into multiple scale is depend on the concentric circles as we got after performing 2D Fast Fourier Transform (FFT) of input image. By band passing the images into different angles or orientation is depending on the scale j and angle.

B. Feedforward Network

Artificial neural networks (ANNs) [8] are networks of simple processing elements (called ‘neurons’) operating on input data and communicating with neighbor neurons connected with each other. ANN design is motivated by the design of an original biological brain. But the processing method and the structure or architectures of ANN have a far difference with biological brain. Neural networks are having so many types, but the basic principles are very similar.

Each neuron of the network is able to receive input data or signals, to process the input data and to send an output signal. Every neuron is connected at least with one neuron, and each connection is assigning a real number, called the weight coefficient or weight vector. Weight of a neuron reflects the degree of importance of the given link of connection in the ANN. Neural network has the power to identify approximate value that’s why it is used as a universal approximator. It means it can realise an arbitrary mapping of one vector space onto another vector space [9].

The main advantage of ANN is the fact, that they are able to get some prior information from data which is unknown or hidden in data. Process of extracting or ‘capturing’ the unknown information is called ‘learning of artificial neural network’ or ‘training of artificial neural network’. In mathematical language to learn or to train means to adjust the value of weight which was applied on a particular neuron.

Training process of ANN is having two main types: supervised and unsupervised training. In supervised training (e.g. multi-layer feed-forward (MLF) neural network) means, that neural network knows the expected or desired output and adjust the weight coefficients in such a way so we will get desired output . Whereas in unsupervised training (e.g. Kohonen network [4]) means, during the training process we don’t know the desired output, and we trained the network to some finite numbers so we will get a stable state.

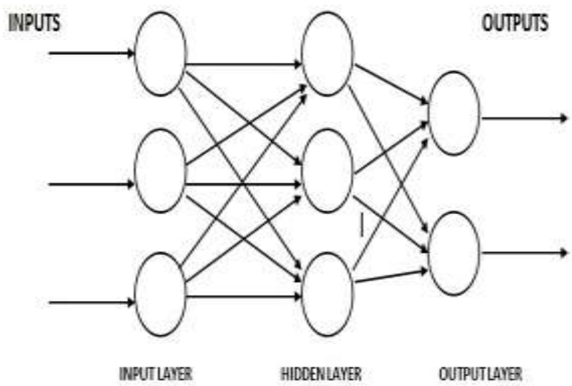

Figure 2: Feed-forward Network

IV. MULTI -LAYER FEED-FORWAD IMAGE ENHANCEMENT FILTER(MLFFIEF):

In proposed paper the flow chart of the process is as follows:

Proposed multi layer feed forward [10] image enhancement network technique use the curvlet transforms, feed forward artificial neural network and histogram matching technique. Corresponding steps in flow chart of proposed technique is represented in Figure 3. Process flow is as follows:

1. *Region identification and separation:* Curvlet transformation [11] is used to identify bright regions of an original gray scale image.
2. *Histogram computation:* A histogram of original image and histogram of pixels after training by using feed forward network are computed.
3. Modify original image histogram with respect to the histogram of image pixels after training with feed forward network.

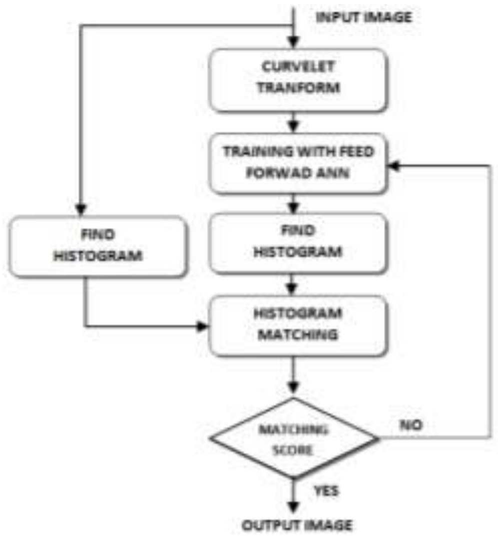

Figure3: Flow chart of proposed method

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V. EXPERIMENTAL RESULTS

Our proposed method was tested with cameraman gray scale image and has been compared with existing histogram equalization methods such as Histogram Equalization (HE), Multi Histogram Equalization (MHE), and Image Dependent Brightness Preserving Histogram Equalization (IDBPHE). Competition chart in Figure 3 represents the effectiveness our proposed method and other existing methods on cameraman image.

To do the analysis of our proposed method with other existing image enhancement method we use two basic parameters for evaluation of a gray scale image named, Peak Signal to Noise Ration (PSNR) and Absolute Mean Brightness Error (AMBE).

Table1: AMBE and PSNR values for cameraman Image

Methods	AMBE *Cameraman image*	PSNR *Cameraman image*
HE	64.73	18.58
MHE	60.51	20.78
IDBPHE	48.9	23.59
Proposed	**40.36**	**27.76**

Figure 4: Original Image of Cameraman

Figure 5: Result of HE on image Cameraman

Figure 6: Result of MHE of image Cameraman

Figure 7: Result of IDBPHE of image Cameraman

Figure 8: Result of MLFFIEF of cameraman image

In a gray scale image the degree of brightness preservation is measured by Absolute Mean Brightness Error (AMBE) [12]. To preserve the degree of brightness Smaller AMBE is better. Smaller AMBE indicates that mean value of brightness preserving of original and result images are almost same. AMBE is given by,

$$AMBE(X,Y) = | M_X - M_Y |$$

Where M_X, M_Y represent mean values of the input image X and output image Y, respectively.

In a gray scale image the degree of contrast is measured by the Peak Signal to Noise Ration (PSNR) [11]. To improve the contrast of a gray scale image greater PSNR is better. Greater PSNR indicates better image quality.

PNSR is given by,

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) = 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right)$$

Here, image maximum pixel value is represented by MAX_I . If we are using 1 byte size for a pixel than the MAX_I is 255. More generally, when we are using B bits for representing a sample, than MAX_I is $2^B - 1$.

Mean squared error (**MSE**) is defined as:

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

Hera image maximum pixel value is represented by MAX_I, I and K are the original and enhanced images respectively and the size of the image is M X N.

Experimented result on cameraman image by performing the existing histogram matching technique and proposed technique are compared on the basis of value of AMBE and PSNR.

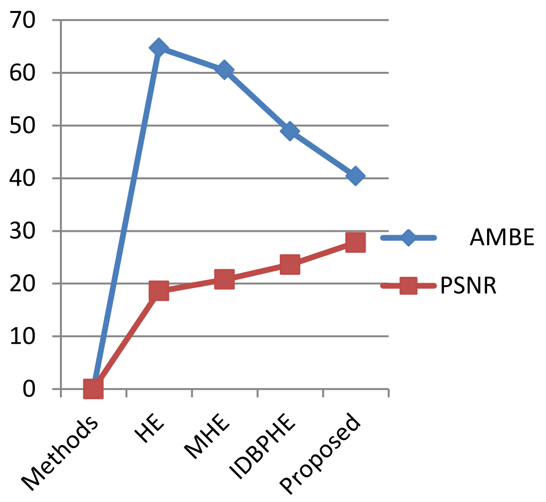

Figure 9: AMBE and PSNR value of HE, MHE, IDBPHE and MLFFIEF for Image cameraman

VI. CONCLUSION

We propose Multi -Layer Feed-Forward Image Enhancement Filter (MLFFIEF) technique for image contrast enhancement and preserving the brightness after image enhancement. In our work we use Curvlet transform for feature extraction, Feed Forward ANN and histogram matching techniques enhance the original image contrast level and also preserve the brightness. Proposed method is checked on standard cameraman image. Proposed method enhances the contrast and improves the image visualization more effectively.

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