Image Contrast Enhancement with Brightness Preserving Using Feed Forward Network

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Abstract—Image improvement techniques are very useful in our daily routine.In the field of image enhancement Histogram Equalization is a verypowerful, effective and simple method. 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.

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I. Introduction

Human is gifted by god with five senses – sight, hearing, touch, smell and taste – which humans use to perceive their environment. Out of these five senses, sight is the most powerful. Image Enhancement is a simple, effective and most widely usedarea among all the digital image processing techniques. The main purpose of image enhancement is to bring out detail that is hidden or not clearly visible in an image. Another purpose of image enhancement is to control contrast and brightness in such a way so the image will become more valuable to take a decision in consumer electronics and medical instrumentation. Whenever an analog image is converted into digital format there are so many chances that some unwanted signals or noise will be added with the original signal. Image enhancement is one of the most important and demandable areas in digital image processing. Image enhancement techniques are subdivided into two main categories:

1. Spatial domain methods, which operate directly on pixels, and

2. Frequency domain methods, which operate on the Fourier transform (frequency) of an image.

The goal of brightness preserving and contrast enhancement in general is to provide a more appealing image and clarity of details. These enhancements are intimately related to different attributes of visual sensation.

Gray Scale image

A gray scale image in photography and computing, is a digital image in which the value of each pixel is a single sample (only single information), that is, it carries only intensity information. Gray scale image is also called a black-and-white image. It is a combination of gray and white shades.

Grayscale images are most commonly used in consumer electronics and medical instrumentation and are often the result of measuring the intensity of light at each pixel in a single band of the electromagnetic spectrum and we capture only one frequency level.

Image Enhancement

Image enhancement is among powerful, easily understandable and most demanding area of digital image processing. Basically, the idea behind image enhancement techniques is to bring those features in the front which are more demanding and hide or don't show the information which is not having any use. Figure 1 represents the basic steps for image enhancement, which clearly shows that improvement in the quality of an image or make it better is the main aim of image enhancement.

Histogram Equalization

Histogram equalization is an automatic contrast enhancement technique where pixels of the entire image are uniformly distributed among all possible grey levels. Histogram equalization is global technique as pixels are modified by a transformation function based on the grey level content of an entire image. But here we need to

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enhance details over small areas in an image. We devise transformation functions based on the properties in the

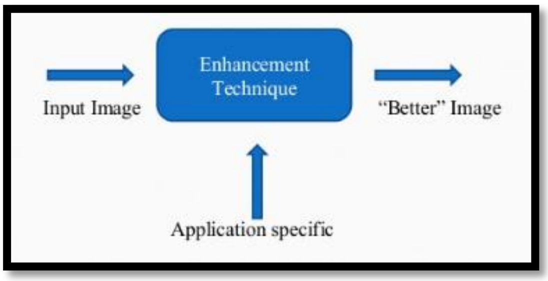

Figure 1: Image Enhancement

neighbourhood of every pixel in the image. The procedure of histogram equalization is to define a square or rectangular neighbourhood and move the centre of this area from pixel to pixel. At each location, the histogram of the points in the neightbourhood is computed and the transformation function is obtained. This function is finally used to map the grey level of the pixel centred in the neighbourhood. The centre is then moved to an adjacent pixel location and the procedure is repeated until we will get the more accurate location of that pixel. In this transformation only one new row or column of the neighbourhood changes during a pixel to pixel translation of the region, updating the histogram obtained in the previous location with the new data introduced at each motion step is possible.

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 (multipeak 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. Multi-Histogram 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 Preserving 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

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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.

The Fourier transform expresses a function of time (or signal) in terms of the amplitude (and phase) of each of the frequencies that make it up. Then the wavelet transform was proposed as it is localized in both time and frequency whereas the standard Fourier transform is only localized in frequency, Now Curvelet transform is a higher dimensional generalization of the Wavelet transform designed to represent images at different scales and different angles. It actually overcomes the missing directional selectivity of wavelet transforms in images. We can distinguish in terms of points and curves singularities between the three as:

- ***Fourier transform*:**

A discontinuity point affects all the Fourier coefficients in the domain. Hence the FT doesn't handle points discontinuities well.

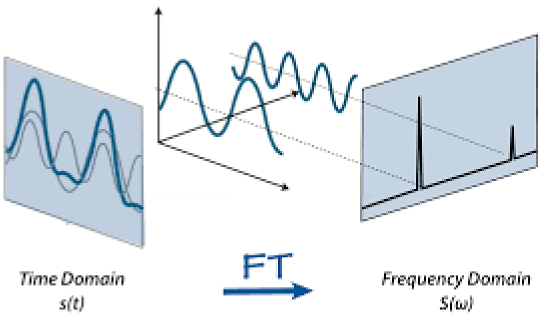

Figure 2: FourierTtransform

- ***Wavelet Transform:***

Point: it affects only a limited number of coefficients. Hence the WT handles points discontinuities well.

Curve: Discontinuities across a simple curve affect all the wavelets coefficients on the curve.Hence the WT doesn't handle curves discontinuities well.

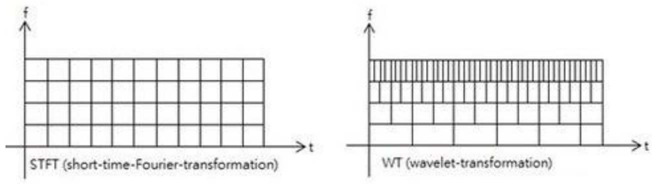

Figure 3: *Wavelet Transform*

- ***Curvelet Transform:***

Curvelets are designed to handle curves using only a small number of coefficients. Hence the Curvelet handles curve discontinuities well.

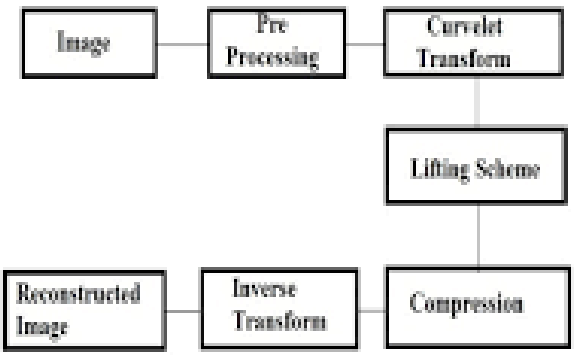

Figure 4: *Curvelet Transform*

- **Feedforward Neural Network**

Feedforward neural network are used for classification and regression, as well as for pattern encoding. In the first case, the network is expected to return a value **z=f(w,x)** which is as close as possible to the target *y*. In the second case, the target becomes the input itself so that the network is expected to minimize **V(x,y,f(w,x)).** In the case of classifiers the output contains a code of the class of the input. In the simplest case, one is interested simply in the decision on the membership of *x* to a certain class **x∈C**. Hence if y=1 then the target is y=0, otherwise 9. Multiclassifiers can be constructed in different ways. We must use an output layer with a number of units that is enough to code the class. In this a discussion is suggested on different class encodings. In particular, the one-hot encoding is compared with the Boolean encoding. The analysis returns a result which explains why most of the real-world experiments have been using one-hot encoding instead of more compact output representations.

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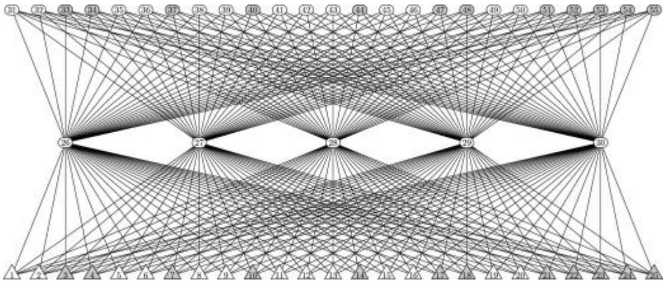


Figure 5: Feedforward Neural Network

In order to deal with multiclassification, we can either use

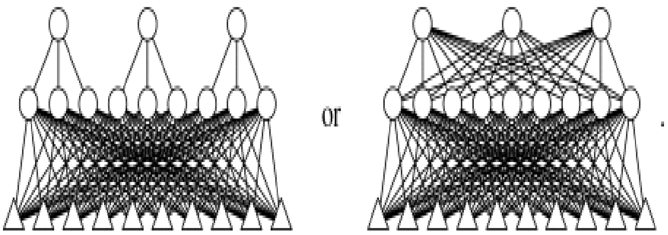


Figure 6: Multiclassification of Neural Networks

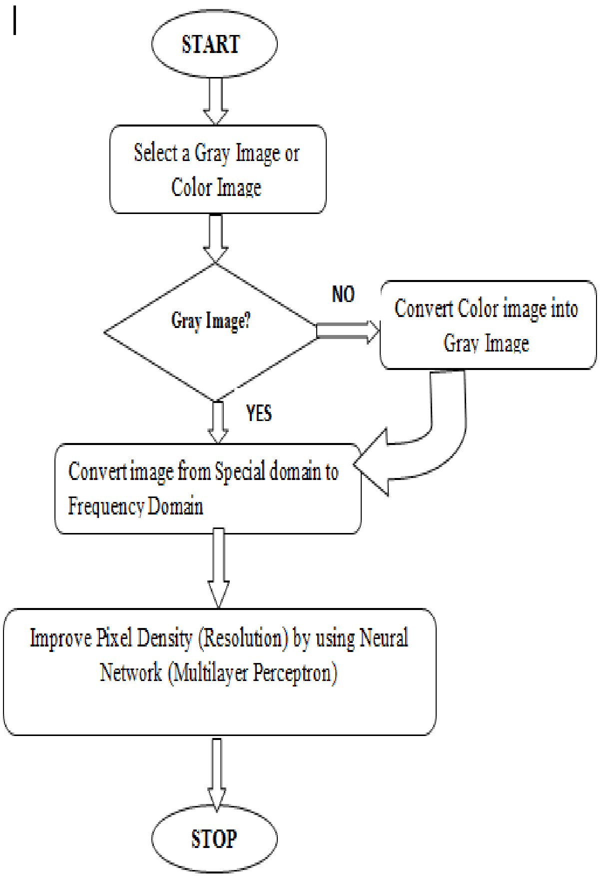
The left-hand side network is a modular architecture where each of the three classes is connected to three distinct hidden neurons. On the other hand, the right-hand side configuration is a fully-connected network that leads to a richer classification process, in which all the hidden units contribute jointly to define the classes. Of course, in this case the network optimizes the discrimination capabilities, since the competition amongst the classes takes place by using all the features extracted in the hidden neurons. However, the left-side network presents the remarkable advantage of being modular, which favors the gradual construction of the classifiers. Whenever we need to add a new class, the fully-connected network does require a new training, whereas the modular one only requires training the new module. Most of the issues raised in classification also hold for regression. However, it is worth mentioning that the output neurons are typically linear in regression tasks, since there is no need to approximate any code.

The encoding architecture is an extension of matrix factorization in linear algebra. In that case we are given a matrix *T* and we want to discover factors W1,W2, so T=W2W1. The process of encoding consists of mapping $x \in R^d$ to a lower dimension y^-, which is the number of hidden units. One would like the network to return z=f(w,x)≃x, so that the output of the hidden neurons *h* can be regarded as a code of the input *x*.

IV. MULTI –LAYER PERCEPTRON IMAGE ENHANCEMENT FILTER(MLPIEF):

Proposed Algorithm:

Following flow chartrepresents the working of our proposed method:



III. EXPERIMENTAL RESULTS

Ourproposed 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 11 represent 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).

Methods	AMBE	PSNR
	Cameraman image	Cameraman image
HE	64.73	18.58

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MHE	60.51	20.78
IDBPHE	48.9	23.59
Proposed	**40.36**	**27.76**

Table1: AMBE and PSNR values for cameraman Image

Figure 7: Original Image of Cameraman

Figure 8: Result of HE on image Cameraman

Figure 9: Result of MHE of image Cameraman

Figure 10: Result of IDBPHE of image Cameraman

Figure 11: Result of MLPIEF 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,

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

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.

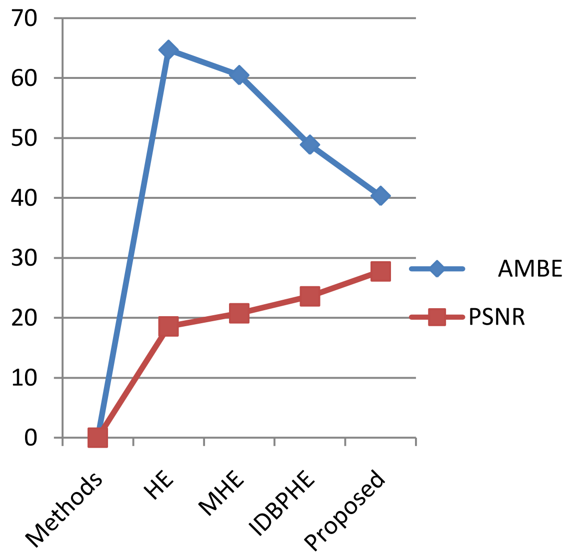

Figure 12: AMBE and PSNR value of HE, MHE, IDBPHE and MLPIEF for Image cameraman

V. 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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