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Image Contrast Enhancement with Brightness Preserving using Curvelet Transform and Multilayer Perceptron

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Abstract: Image Improvement Techniques Are Veryuseful In Our Daily Routine. In The Field Ofimage Enhancement Histogram Equalizationis A Very Powerful, Effective And Simplemethod. But In Histogram Equalizationmethod The Brightness Will Disturb Whileprocessing. Original Image Brightnessshould Be Kept In The Processed Image. Soimage Contrast Must Be Enhanced Withoutchanging Brightness Of Input Image. In Ourproposed Method Of Image Contrastenhancement With Brightness Preservingusing Curvelet Transform And Multilayerperceptron We Will Solve This Problem Andget Better Result Than Existing Methods.Results Are Compared On The Basis Of Twoimportant Parameter For Image Quality Suchas Absolute Mean Brightness Error (Ambe)And Peak Signal To Noise Ratio (Psnr).

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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 used area 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 imageprocessing. 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.

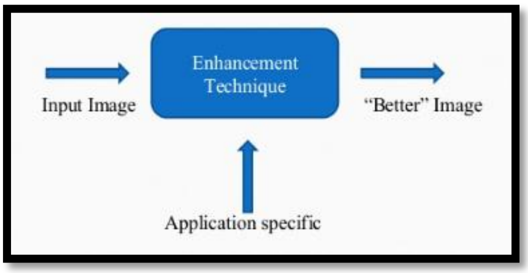

Figure 1: Image Enhancement

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 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.

CONTRAST ENHANCEMENT USING HISTOGRAM EQUALIZATION WITH BIN UNDERFLOWAND BIN OVERFLOW

Contrast enhancement (CE) is used widely in image processing. One of the most popular CE methods is the histogram equalization (HE) [1, 2]. The HE uses the cumulative distribution function (CDF) of a given image as a mapping from the given image to the enhanced image. The image enhanced by the HE follows the uniform distribution [2]. The fact that the enhanced image utilizes the available levels fully reflects the enhanced contrast. The HE has several nice properties. The HE is simple. All it takes to apply the HE is to estimate the probability density function (PDF) and sum it cumulatively to obtainthe CDF. When simple bin counting is used for the estimation of the PDF, as is the most case, the HE becomes a non-parametric method [3]. It adapts to the statistics of the given image no matter what distribution it may be. The HE is very effective. It provides images with uniform distributions. But it may be too effective for some images or for some applications. Although the HE surely provides images of higher contrast, it cannot be said it provides images of higher quality. Images with uniformly distributed levels are not usually very pleasing.

The proposed Histogram Equalization (HE) is to put constraints on the gradient of the mapping function used to enhance the contrast of gray image which increase picture quality. We put constraints on the estimated PDF to improve the result, so we can increase the contrast and maintain the brightness. The constraints work as if we fill the bin for the PDF estimation up to a point when the bin has underflow value, and throw away the noise over another point when the bin has overflow value. By setting the two points for the underflow and overflow, we can control the rate of enhancement of pixel quality and effectiveness of the algorithm. In fact, we can change the rate of enhancement gradually from non HE to the full HE with a single parameter. The required operations are the thresholding and adjustment in the values, which can be implemented efficiently either by software or hardware. With the processing rate control mechanism, the HE can be used to perform various tasks such as the black/white level stretch [4, 5] of pixel to enhance contrast, or the brightness control [4].

IMAGE DENOISING USING SELF-ORGANIZING MAP-BASED NONLINEAR INDEPENDENT COMPONENT ANALYSIS

Since there are various algorithms based on the ICA concept have been employed successfully in various fields of multivariate data processing to enhance an image where multiple curves are present, from biomedical signal applications and communications to financial data modeling and text retrieval.

The use of Self Organizing Map (SOM) based separating structures can be justified as SOMs perform a nonlinear mapping from an input space to an output one usually represented as a low dimensional lattice. Using some suitable interpolationmethod (topological or geometrical), the map can be made continuous to provide estimates of the unknown signals (unwanted signal or noise). However, there are difficulties associated with the nonlinear BSS (NLBSS) problem, such as its intrinsic indeterminacy and the unknown distribution of sources as well as the mixing conditions (which depend on the strength of the unknown nonlinear function involved in the mixing process), and the presence of noise (correlated or not). All these make it difficult for a complete analytical study of SOM behavior when applied in this context.

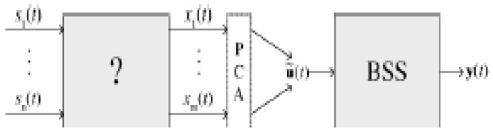

Figure 2: General BSS mixing and separating structure.

Many data processing applications concern the removal of noise with improving the signal value and most BSS research using ICA techniques concerns specific noise distributions (usually additive noise) or is based on the low amplitude/noiseless model. In the real world most of the signals are corrupted during transmission. A normal signal became a complex signal by the addition of noise. Signal-to-noise-ratio (SNR) provides the information about signal and noise level in a complex signal.

This work constitutes a first attempt towards a SOM based noise removal method for image contrast enhancement. SOM is very effective due to non-linear projection property inherent from neural networks and offers an alternative solution to existing denoising schemes. Its main advantages are (i) that it performs in a completely blind context where

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there is no prior knowledge concerning the noise-free images and noise properties, and (ii) it can provide satisfactory results from only two noisy frames.

EFFICIENT ALGORITHM FOR CONTRAST ENHANCEMENT OF NATURAL IMAGES

Contrast enhancement techniques are commonly used in various applications where quality of image is very important to take commercial and human life decision. Main objective of image enhancement is to improve image quality depending on the requirement in that process or application perspective. Image contrast is an important factor for estimation of gray and color image quality.

The contrast enhancement is a process that allows image features to show up more visibly by making best use of the color presented on the display devices. During last decade a number of contrast enhancement algorithms have been developed for contrast enhancement of images for various applications. These are histogram equalization [12], global histogram equalization [30], local histogram equalization [4], adaptive histogram equalization and Contrast Limited

The proposed algorithm is consists of two stages: In first stage the poor quality of image is process by modified sigmoid function and in second stage the output of first stage is further process by contrast limited adaptive histogram equalization to enhance contrast of image. The proposed algorithm is abbreviated as Adaptive Contrast Enhancement Based on modified Sigmoid Function (ACEBSF).

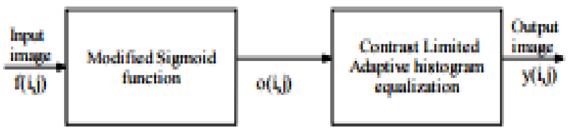

Figure 3: Block Diagram of Proposed method

This paper highlighted contrast enhancement of natural gray scale images. In this paper a new contrast enhancement algorithm was proposed for image enhancement purpose for various applications. This algorithm was tested on different gray scale natural images. The qualitative and subjective enhancement performance of proposed ACEBSF algorithm was evaluated and compared to other state-of-art contrast enhancement techniques for different gray scale natural images. The performance of proposed ACEBSF algorithm was evaluated and compared in terms of EME, EMF and Execution time. The proposed ACEBSF algorithm proved its superiority due to its better performance, fast speed, and low CPU processing time for different natural gray scale images. Therefore, proposed ACEBSF algorithm performed very effectively and efficiently for contrast enhancement of gray scale natural images.

OBJECT-BASED IMAGE ENHANCEMENT TECHNIQUE FOR GRAY SCALE IMAGES

Basically image enhancement [3] improves the quality of the image so that the result is more suitable for a specific application and for human perception. Image enhancement techniques are widely used in many real time applications. The contrast enhancement in digital images can be handled by using various point processing techniques[2]-[7] like power law, logarithmic transformations and histogram equalization(HE).Image enhancement using power law transformations depends upon the gamma values, if the gamma value exceeds 1, the contrast is reduced.The logarithmic transformation [2]-[4] improve the contrast of the image, but increases the overall brightness.The most widely used technique of Contrast enhancement is Histogram Equalization (HE)[1]-[5], which works by flattening the histogram and stretching the dynamic range of the gray-levels using the cumulative density function of the image. However, there are some drawbacks with histogram equalization [8] especially when implemented to process digital images. Firstly, it converts the histogram of the original image into a uniform histogram with a mean value at the middle of gray level range. So, the average intensity value of the output image is always at the middle – or close to it.

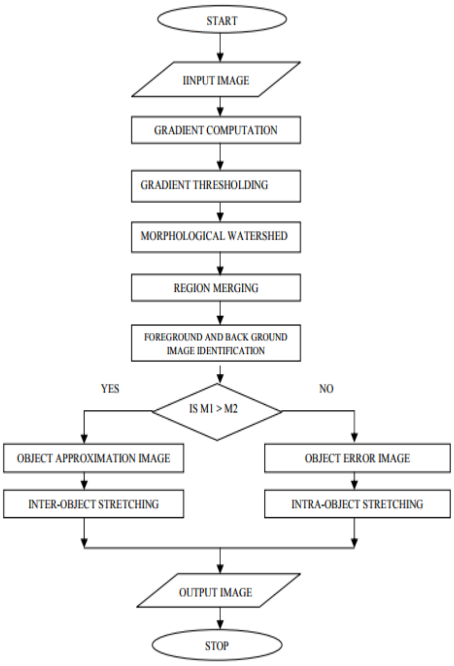

Figure 4: Flow Chart of Object Based image enhancement method

The process of object based contrast stretching includes the pre-processing step by finding the edges of an image, and then the threshold is applied on the gradient image which is given as marker to the morphological watershed algorithm. The morphological watershed segments the image into

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various objects. As the watershed algorithm results in over segmentation, the region growing algorithm is applied for partitioning the image into two significant regions i.e. the foreground and background regions. The contrast stretching is separately applied to each region and after enhancement of each region; the regions are merged to form an enhanced image. The complete process of object based contrast stretching is given in figure3.

BACKGROUND OF THE PROBLEM

One of the first applications of digital images was in the newspaper industry, when pictures were first sent by submarine cable between London and New York. Introduction of the Bartlane cable picture transmission system in the early 1920s reduced the time required to transport a picture across the Atlantic from more than a week to less than three hours. Specialized printing equipment coded pictures for cable transmission and then reconstructed them at the receiving end.

PROPOSED WORK

MULTILAYER PERCEPTRON (MLP):

There are many definitions of artificial neural networks. We will use a pragmatic definition that emphasizes the key features of the technology. ANNs are learning machines built from many different processing elements (PEs). Each PE receives connections from itself and/or other PEs. The interconnectivity defines the topology of the ANN. The signals flowing on the connections are scaled by adjustable parameters called weights, w_{ij}. The PEs sums all these contributions and produce an output that is a nonlinear (static) function of the sum. The PEs' outputs become either system outputs or are sent to the same or other PEs. Figure 1 shows an example of an ANN. Note that a weight is associated with every connection.

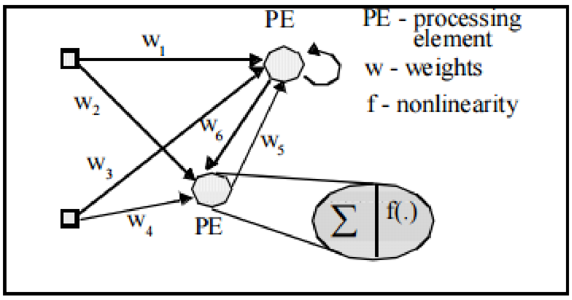


Figure 5:An artificial neural network

Rosenblatt's perceptron is a pattern recognition machine that was invented in the 50's for optical character recognition. The perceptron has multiple inputs fully connected to an output layer with multiple McCulloch and Pitts PEs (Figure 8). Each input $x_j$is multiplied by an adjustable constant w_{ij} (the weight) before being fed to the j^{th} processing element in the output layer, yielding

$$y_j = f(net_j) = f\left(\sum_i w_{ij}x_i + b_j\right)$$

whereb_j is the bias for each PE. The number of outputs is normally determined by the number of classes in the data. These processing elements (PEs) add the individual scaled contributions and respond to the entire input space.

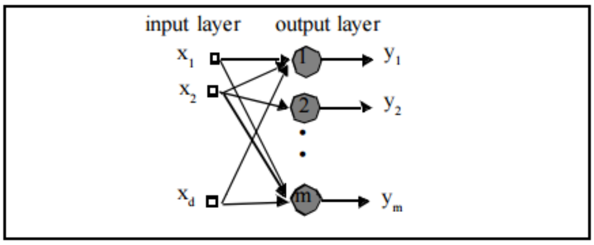


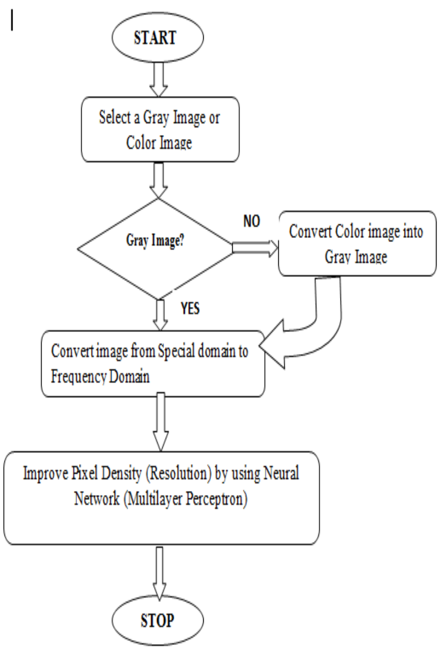
Figure 6: The perceptron with d inputs and m outputs (d-m)

After studying the function of each M-P PE, we are ready to understand the pattern recognition power of the perceptron. The M-P PE is restricted to classify only two classes. In general the problem is the classification of one of m classes. In order to have this power the topology has to be modified to include a layer of m M-P PEs, so that each one 27 of the PEs is able to create its own linear discriminant function in a D dimensional space (Figure 9). The advantage of having multiple PEs versus the single M-P PE is the ability to tune each PE to respond maximally to a region in the input space.

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

PROPOSED ALGORITHM:

Following flow chartrepresents the working of our proposed method:



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

Table1: AMBE and PSNR values for cameraman Image

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 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,

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

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, thanMAX_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.

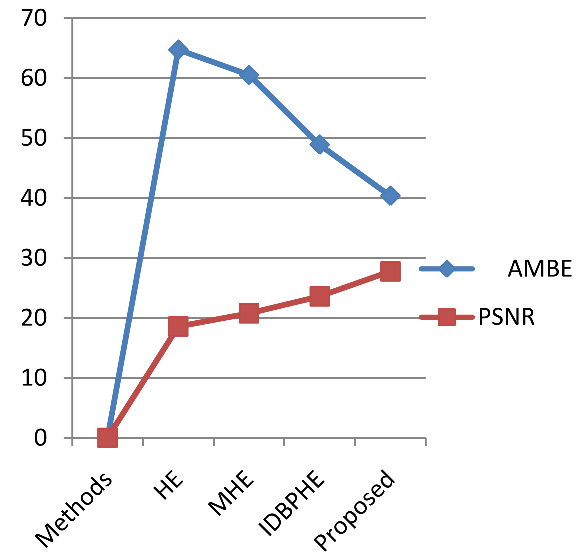

Figure 9: AMBE and PSNR value of HE, MHE, IDBPHE and MLPIEF for Image cameraman

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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