HYBRID TECHNIQUE FOR IMAGE ENHANCEMENT

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Abstract - *Image enhancement plays an important role in the computer vision systems. The basic three approaches in image enhancement technique are spatial domain, frequency domain and hybrid techniques. Recently much work is completed in the field of images enhancement. Many techniques have previously been proposed up to now for enhancing the digital images. In this paper, a hybrid technique for image enhancement has been designed. Here first the frequency domain techniques are used followed by the spatial domain techniques and the performance of the image is calculated using MSE and PSNR.*

Key Words: frequency domain techniques, hybrid technique, image enhancement, spatial domain techniques.

1. INTRODUCTION

Image enhancement plays a fundamental role in image processing applications where the experts make decisions with respect to the image information. Form of image enhancement include noise reduction, edge enhancement and contrast enhancement. Enhancement may be the technique of improving the superiority of an electrically stored image. To produce a picture lighter or darker or to increase or decrease contrast. Image enhancement is to improve the sensitivity of information in images for human viewers or to offer enhanced input for other regular image processing techniques. The aim of image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide `better' input for other automated image processing techniques.

Image enhancement techniques can be divided into two broad categories:

1. Spatial domain methods, which operate directly on pixels

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

2. SPATIAL DOMAIN TECHNIQUES

The term spatial domain means working in the given space i.e. the image. It implies working with the pixel values or in other words, working directly with the raw data. The pixel values are altered to achieve desired enhancement. Image enhancement is applied in every field of science where images are understood and analyzed. For example, medical image analysis, satellite image analysis etc. Let f(x, y) be the original image where f is the grey level value or intensity value and (x, y) are the image co-ordinates. For an 8-bit image, 'f' can take values from 0-255, where 0 represents black, 255 represents white and all the intermediate values represent shades of gray. Image enhancement simply means, transforming an image 'f' into image 'G' using 'T'. The modified image can be expressed as:

$$G(x, y) = T\,[f(x, y)] \qquad (1)$$

For all spatial domain techniques it is simply T that changes. The above equation can also be written as:

$$S = T(r) \qquad (2)$$

Where 'T' is the transformation that maps a pixel value 'r' into a pixel value's'. The results of this transformation are mapped back into the gray scale range as we are here dealing only with grey scale digital images. So, the results are mapped back into the range [0, L-1], where $L=2^k$, k being the number of bits in the image being operated on. Here we will only consider gray level images. The same methodology can be extended for the color images too. A digital gray image has pixel values in the range of 0 to 255.

2.1 Power law transformation

Power law transformation [12] [13] is another commonly used gray level transformation in the spatial domain. It is conceptually similar to alpha rooting in the frequency domain as this is done by raising the input grey level by some power, γ . It is similar in operation to the log transforms in that power law transforms with fractional values of γ map a narrow range of dark input values into a wider range of output values thereby increasing the contrast. However the difference is that unlike the log function, there is an assortment of possible transformation curves obtained by varying the power γ. As the power γ, varies the nature of mapping of the input grey levels to output grey levels changes. The transformation can be mathematically represented as

$$s = b.r^{\gamma}$$

where s is the output grey level, r is the input grey level, b is a scaling constant and γ is the power to which the input grey level is raised. One significant advantage of the transformation is that it is possible to control the transformation function by varying the parameter γ . We can make the image tone darker or brighter by changing the γ values. A point worth noting is that values of $\gamma < 1$ expand a narrow range of dark grey levels to a wider range. This makes the overall tone brighter. The reverse holds for $\gamma > 1$.

2.2 Log transform

Log transformations [12] [13] are one of the elementary image enhancement techniques of the spatial domain that can be effectively used for contrast enhancements of dark images. The log transform is essentially a grey level transform which means that the grey levels of image pixels are altered. This transformation maps a narrow range of low grey level values in the input image to a wider range of output levels. The opposite is true for higher input grey levels. Thus the dark input values are spread out into the higher gray level values which improve the overall contrast and brightness of the image. The general form of the log transformation can be mathematically represented as

$$s = c \log (1 + r)$$

where, s is the output grey level, r is the input grey level and c is a constant. It is assumed that $r \geq 0$.

3. FREQUENCY DOMAIN TECHNIQUES

The transform domain enables us to view the frequency content of the image. This is usually done by taking the discrete cosine transform, the discrete Fourier transform or any other orthogonal transform [12] of the image. The principle behind the transform-based methods of image enhancement consists of computing a 2-D discrete unitary transform of the image, for instance the 2-D DFT, manipulating the transform coefficients by an operator M, and then performing the inverse transform. The orthogonal transform of the image has two components: the magnitude and the phase. The magnitude consists of the frequency content of the image. The phase is used to restore the image back to the spatial domain. It holds the relative positioning information (angle) of the magnitude content.

3.1 Discrete Wavelet Transform

The Wavelet transform [15] is a transform; which provides the time-frequency representation. (There are other transforms which give this information too, such as short time Fourier transforms, Wigner distributions, etc.).Often times a particular spectral component occurring at any instant can be of particular interest. In these cases it may be very beneficial to know the time intervals these particular spectral components occur. Wavelet transform is capable of providing the time and frequency information simultaneously, hence giving a time frequency representation of the signal. How wavelet transform works is completely a different, and should be explained after Short time Fourier Transform (STFT). The WT was developed as an alternative to the STFT. It suffices at this time to say that the WT was developed to overcome some resolution related problems of the STFT. To make a short, we pass the time-domain signal from various high pass and low pass filters, which filter out either high frequency or low frequency portions of the signal. This procedure is repeated, every time some portion of the signal corresponding to some frequencies being removed from the signal.

3.2 Discrete Cosine Transform

The DCT is a widely used transformation in transformation for data compression. It is an orthogonal transform, which has a fixed set of basis functions, an efficient algorithm for computation, and good energy compaction and correlation reduction properties.

Discrete cosine transform (DCT) is widely used in image processing, especially for compression. Some of the applications of two dimensional DCT involve still image compression and compression of individual video frames, while multidimensional DCT is mostly used for compression of video streams. DCT is also useful for transferring multidimensional data to frequency domain, where different operations, like spread spectrum, data compression, data watermarking, can be performed in easier and more efficient manner. A number of papers discussing DCT algorithms are available in the literature that signifies its importance and application.

4. LITERATURE SURVEY AND REVIEW

Mrs.Preeti.Kale *et.al* [1] presented the comparison of two image enhancement algorithms i.e. Hybrid Binarization and Histogram Equalization and concluded that hybrid binarization method outperforms the histogram equalization algorithm.

Preeti Beniwal *et.al* [2] proposed a hybrid technique which is a combination of median filter and wiener filter. Here the author added three noise i.e. impulse noise, gaussian noise, blurredness and apply the noisy image to hybrid filter. The final filtered image is depended upon the blurring angle and the blurring length and the percentage of the impulse noise.

Zhengya Xu *et.al* [3] introduces a novel image enhancement methodology driven by both global and local processes. The methodology was compared with other classical image enhancement techniques, such as linear contrast stretching and histogram equalization.

Daniel Fajardo-Delgado Xu *et.al* [4] introduces a new hybrid genetic algorithm, called GARIN, which takes as input a noisy image and generates as output a reduced noise version of the same image. Experimental results shows that, compared with other filters of literature, the algorithm GARIN efficiently removes impulsive noise in color images while, at the same time, it preserves their main features.

Zhang Chaofu *et.al* [5] presented a hybrid algorithm to enhance the image. It is use of the Gauss filter processing to enhance image details in the frequency domain and smooth the contours of the image by the top-hat and bot-hat transforms in spatial domain.

V.Janani *et.al* [6] has provided an empirical review on image processing concepts and briefed about spatial, frequency and hybrid domains. They also presented different techniques and filters that have been used by the researchers to enhance the given infrared image by improving its features such as brightness, noise removal and contrast etc.

T.Romen Singh *et.al* [7] presented an image enhancement technique by applying Power Law function on global DCT domain of an input image like Alpha Rooting. This technique has achieved three aspects of enhancement like brightness, global contrast stretching and edge sharpening/smoothness with a single Power Law function with respective parameters.

Mr. Salem Saleh Al-amri *et.al* [8] presented the study two types of the contrast enhancement techniques, linear contrast techniques which includes Max-Min contrast method, Percentage contrast method and Piecewise contrast technique and non-linear contrast techniques i.e. Histogram equalization method, Adaptive histogram equalization method, Homomorphic Filter method and Unsharpe Mask.

Blair Silver *et.al* [9] developed and presented three methods of contrast enhancement i.e. logarithmic transform histogram matching, logarithmic transform histogram shifting, and logarithmic transform histogram shaping using Gaussian distributions based upon the properties of the logarithmic transform coefficient histogram using contrast entropy as a measure of performance and optimization. The performance of these algorithms was compared to two popular enhancement techniques: histogram equalization and alpha rooting. This paper also introduced a variety of measures of contrast enhancement.

Katta Sugamya *et.al* [10] uses DWT to decompose the input image into the four frequency sub bands and for the low-low sub band they estimate the singular value matrix of the image. Then, the improved image is reconstructed by applying IDWT. This technique also estimates the singular value matrix using singular value decomposition (SVD).

5. PROPOSED TECHNIQUE

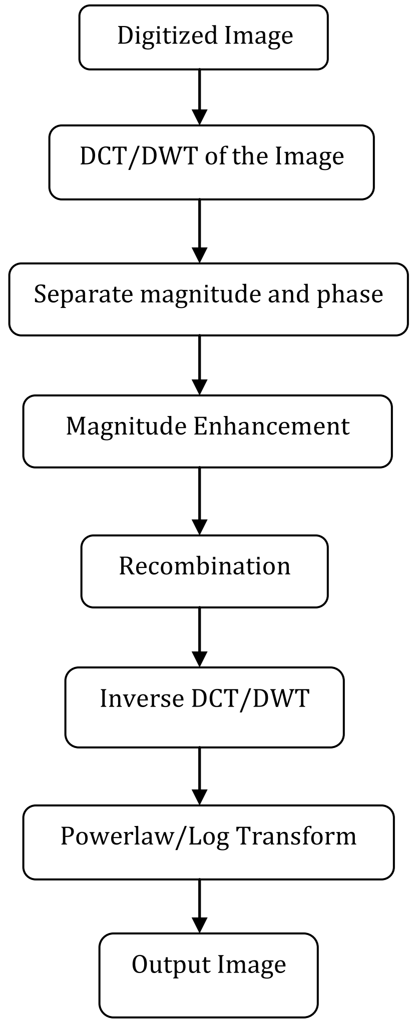

Fig.1 Block Diagram of Proposed Technique

As per the proposed system initially image is analyzed using frequency domain procedure. Here DCT/DWT of the image is obtained to separate the magnitude and phase spectrum. Once magnitude and phase part is separated the intensity levels are improved by increasing the magnitude of the available pixels. The result of magnitude enhancement is many a time poor in contrast and brightness and suffers from the graying effect. To counter this problem, we subject the result to spatial gray level contrast enhancement transforms.

The separated improved magnitude is recombined with the phase as per applying inverse frequency technique. Here we apply IDCT/IDWT to recover the image then spatial domain procedures are applied to the recovered output. The resultant is a hybrid enhanced output because of combination of frequency and spatial domain procedures. The log transform scales the narrow range of dark values to a wider range and also allows us to control the level and extent of enhancement by varying the power parameter. The addition of the log transform and power law transform enhances the quality of the image with good contrast and brightness [11].

Table -1: MSE and PSNR Values for Different Images

Different Techniques	Cameraman		Lena	
	MSE	PSNR	MSE	PSNR
DWT+Powerlaw	131.31	26.98	110.23	27.74
DWT	126.77	27.13	113.70	27.60
DWT+Log	56.54	30.64	56.44	30.64
DCT	0.78	49.21	0.48	51.31
DCT+Powerlaw	0.55	50.75	0.42	51.92
DCT+Log	0.26	53.99	0.18	55.52

6. CONCLUSIONS

Different hybrid techniques are applied on cameraman and lena image and the results are as shown in table above giving better peak signal to noise ratio and mean square error.

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