Comparison on Different Image Enhancement Techniques

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ABSTRACT
Enhancement of image is the most crucial step in the digital image processing. The aim of image enhancement is to ameliorate the visual effects of an image for human viewing.It is mandatory to enhance the image and to perform operations for noise removal. The enhancement technique varies in accordance to various considerations and can be distinguished into two categories: Spatial Domain and Frequency domain based techniques. In this paper a review of various image enhancement techniques is done.

Keywords
Image enhancement methods, spatial domain, and Frequency domain

1. INTRODUCTION
Image enhancement is an active area of research in medical imaging in the recent years. The goal of enhancement is to process an image so that the output results are more appropriate than the original input image for a precise application. Applying image enhancement operations on low quality image is a difficult approach as we cannot clearly draw out objects from the dark background.

Image enhancement, as the noteworthy techniques in digital image processing, plays crucial part in many fields, such as medical image analysis, remote sensing, high definition television (HDTV), hyper spectral image processing, microscopic imaging etc. It basically gives better visual effects or makes the original image more appealing for computer to process [1].

The most prominent techniques of image enhancement can be split up into two types: Spatial based and Frequency based domain image enhancement. Spatial based domain [2] image enhancement deals on pixels or intensities directly. Frequency based domain [3] image enhancement works on the description of various mathematical functions or signals relative to frequency and it can work directly on the image - transform coefficients (such as Fourier Transform (FT), Discrete Cosine Transform (DCT), and Discrete Wavelet Transform (DWT)).

The outline of this paper is as follows: SectionII deals with literature survey .SectionIII deals with spatial domain image enhancement methods. SectionIV focus on the frequency domain image enhancement methods. SectionV compares the various enhancement methods. SectionVI concludes the paper.

2. LITERATURE SURVEY
In this section, the research work of various authors about image enhancement techniques has been presented.

A. Rivera *et al.* **"Content-Aware Dark Image Enhancement Through Channel Division", 2012[1]** presented an algorithm which enhances dark images, sharpens edges and maintains the smoothness of flat regions. This algorithm takes into consideration an Ad- hoc transformation for each image,thereby mapping functions to each image's characteristics to give maximum enhancement.

B. Deepak Ghimire and Joonwhoan Lee ,**" Nonlinear Transfer Function-Based Local Approach for Color**

Image Enhancement,"2011[4] used a method in which the image enhancement techniques were applied only on the V (luminance value) component of the HSV color image and H and S component were kept unvaried to prevent the change of state of color balance among HSV components.

C. Won Jung *et al.* **" Sharpness Enhancement of Stereo Images Using Binocular Just-Noticeable Difference,"2012 [5]** proposed a new algorithm for stereo images. An effective solution for eliminating the over enhancement of stereo images was proposed. The solution was evaluated using an optimization framework with extra restraint to prevent rise in luminance values.

D. Zhang *et al.* "**Multi-scale Image Enhancement Based on Properties of Human Visual System,"2011[6]** presented the logarithmic image processing(LIP) model and takes into account the characteristics of the human visual system (HVS) to propose a new multi-scale enhancement algorithm.

E. Yasmin *et al.***" Brain Image Enhancement - A Survey,"2011 [7]** This paper describes about enhancement operation which is to applied so as to analyze the brain images precisely in order to diagnose the modality effectively and efficiently. The paper provides an overview of various methods in respect to brain image enhancement.

3. SPATIAL DOMAIN ENHANCEMENT TECHNIQUES
In this image enhance technique manipulations are performed directly on the pixels. Spatial techniques are helpful for modifying the gray level values of individual pixels ,thereby enhancing the entire image.It leads to a problem that it enhance the whole image in a uniform manner thereby producing unwanted results. Demerit of this approach is that sometimes it shifts image boundaries during sharpening . Point processing methods, log transformation, morphological operators, power law transformations- are examples of spatial domain enhancement operations that are given below:-

3.1.1 Point Processing Operation
It is the simplest type of operation where the

neighbourhood is simply the pixel itself. In this case *T* is a point processing operation or a grey level transformation function. Point processing operations take the form as shown in equation (1)

$$a = T(b) \quad (1)$$

Where *T* is a transformation that maps a pixel value b into a pixel value a.

3.1.2 Image Negative

Image negative [8], reverses the pixel value from black to white or vice versa. It takes into condition that if intensity range of input image decreases then intensity range of output image increases and vice versa.

Where, L is the maximum pixel value of the image. This can be expressed as

$$a=L–1–b \quad (2)$$

Where, *a* = negative image or output image

L-1 = maximum pixel value

b = input image

The pixel range for both the input image and negative image is (0, L-1)

Negative images [9] are useful for enhancing white or grey detail embedded in dark regions of an image.

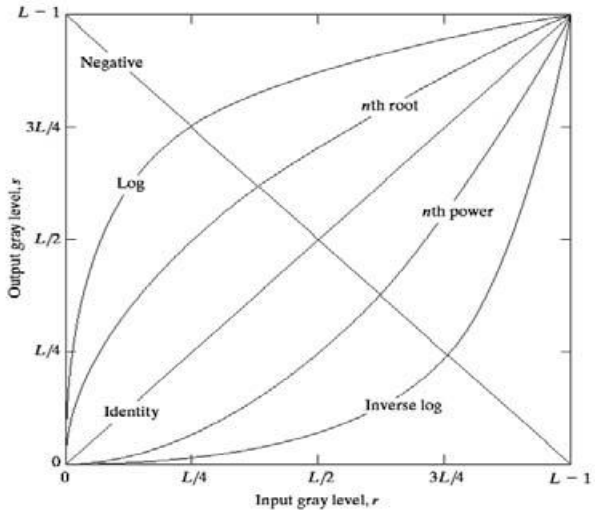

Fig 1- Figure shows basic grey level transformations[2]

3.1.3 Logarithmic Transformations

The log transformations can be defined by this formula

$$s = c * \log (1 + r) \quad (3)$$

Log transformation [10] is used to expand the dark pixels and compress the brighter pixel. In log transformation, the expansion of dark pixels takes place in an image as compared to the higher pixel values. Compression of higher pixel values takes place in log transformation.

3.1.4 Power Law Transformations

The *n*th power and *n*th root curves shown can be expressed as

$$s = c\, r^{\gamma} \quad (4)$$

Such type of transformation function is also called as *gamma* correction [11].Different levels of enhancement are obtained by varying the values of γ. The gamma of various display devices is different. For example Gamma of CRT lies in between 1.8 to 2.5, that means the image displayed on CRT is dark.

4. FREQUENCY DOMAIN TECHNIQUES

In frequency domain method [3] [12] fourier transform of the image is evaluated. In frequency domain, transform the image into another domain i.e. frequency domain. This method consist of 3 basic steps :

1. Convert the input image into its Fourier transform
2. Employ the transfer function

Finally, Inverse Fourier transform is evaluated to get enhanced image.

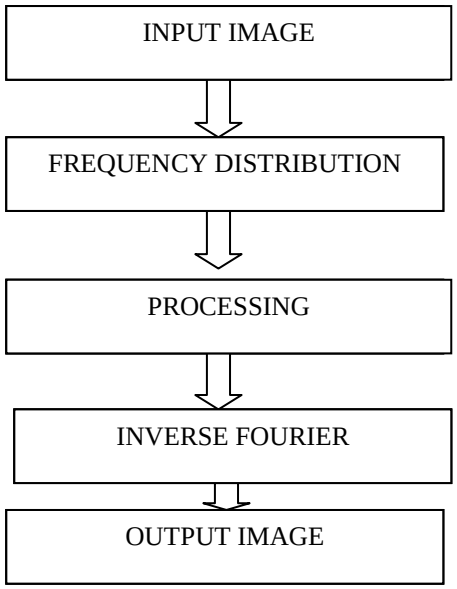

Fig 2 :Steps In Frequency Domain Technique

The merit of using this technique is that calculations are easy since the process of filtering i.e. convolution simplifies to multiplication. The demerit regarding this approach is that for contrast enhancement it is a not a good method.

5. FREQUENCY DOMAIN TECHNIQUES

Table I: Comparison of Image Enhancement Methods

Enhancement Methods	**Merits**	**Demerits**
Adaptive Histogram Equalization[13]	It results in lower contrast thereby creating dark regions.	It does not work efficiently.
Histogram Equalization[14]	It is a most effective method for grayscale images.	It cannot work on color images
Decor relation Stretch[15]	It is used to improve the interrupted images and to improve the classification	It is a most complicated process

	results.	
Image Adjust[16]	It is used to adjust the image intensity at easily.	It does not find the original image.
Image Noise[17]	It is used to reduce the noise from an image easily.	While the dispensable image in low light.

6. CONCLUSION

Image enhancement techniques can alter the images so as to get results which are more appealing. Visual quality of the image can be altered and modified so as to get image free from noise and corruption. In this review paper, advantages and disadvantages of both spatial domain and frequency domain techniques have been summarized . Most of the algorithms are useful for changing the gray values of individual pixels in an image and contrast is also changed of the whole image. The limitation related to image enhancement is that they sometimes do enhancement in an uniform manner and as a result they give undesirable results. There are various techniques that have been developed till now for enhancement but still there is more requirement for achieved by using artificial intelligence schemes for optimization that can produce satisfactory result. The future scope will be the development for effective image enhancement using artificial intelligence so that enhancement might be performed in balanced manner which would be able to provide promising directions on research for optimization.

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