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A Survey on Various Image Enhancement Techniques

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Abstract **-** Image Enhancement is the most important technique in image research. The main function of image enhancement is to improve the visual appearance of an image. Many images such as remote sensing images, medical images, electron microscopy images, satellite images and even real life photographs suffer from poor contrast and noise. So it is necessary to increase the contrast and remove the noise to enhance image quality. This paper presents a literature review on various image Enhancement techniques such as wavelet transform, Contrast Stretching, Histogram equalization, Retinex, etc. Comparison of various techniques concludes the better approach for the future research.

Keywords- Discrete Wavelet Transform, Fingerprint enhancement, Histogram Equalization, Image Enhancement, Retinex, Spatial and Frequency Domain.

I. INTRODUCTION

Image enhancement is a method to process an image so that the resultant image is more suitable than original image for specific application. The attributes of the images are modified during enhancement. The enhancement operations are performed in order to sharpen the image features such as boundaries, edges, modify the image brightness, contrast and gray level distributions. Image enhancement is applied in every field where images are used and analyzed. For example, medical image analysis, analysis of satellite images , etc. The enhancement methods can be classified into two:

a. Spatial Domain Methods
b. Frequency Domain Methods

Spatial domain techniques directly deal with the image pixels. The pixel values are modified to achieve desired enhancement. The spatial domain techniques are simple to understand and the complexity is low which favors real time implementations. But the limitation is it lacks robustness. In frequency domain method, the images are first transferred into frequency domain. That is, the Fourier Transform of the image is computed and all the enhancement operations are performed on the Fourier transform of the image. At last Inverse Fourier transform is performed to get the resultant image. The computation complexity for frequency domain is low but it cannot enhance all part of the image simultaneously. Image enhancement means, transforming an image I into image J using T, Where T is the transformation function. The values of pixels in images I and J are denoted by p and q, respectively.

The pixel values p and q are related by the expression,

$$q = T(p)$$

Where T is a transformation that maps a pixel value p into a pixel value q.

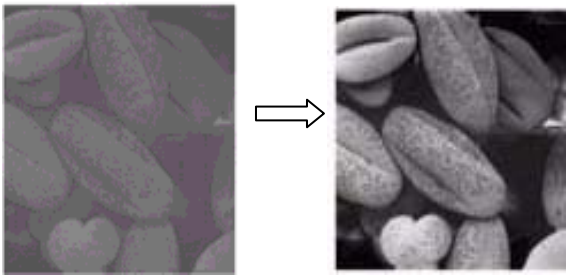

Figure. 1. Showing the Effect of Image Enhancement

In section II, the discussion of literature review is carried out. In section III, the comparison of various image enhancement techniques are done. In section IV, the review on various enhancement techniques are concluded, followed by the references used.

II. LITERATURE REVIEW

A. Jucheng yang, Naixue Xiong, , and Athanasios V. Vasilaos, , **"Two-stage enhancement scheme for low-quality fingerprint images by learning from the images," [1]** proposed a new two-stage enhancement scheme in both spatial and frequency domain by learning from images. To reconstruct the ridges and to enhance the contrast of the ridges, the fingerprint images are first enhanced with the spatial ridge-compensation filter. In the second-stage frequency bandpass filter is used that is separable in the radial- and angular-frequency domains. The parameters of the bandpass filter are taken from both the original image and the first-stage enhanced image. This paper enhances the quality of fingerprint image because of the fast and sharp attenuation of the filter.

B. A. Poljicak, L. Mandic, M. Strgar Kurecic,**" Improvement of the Watermark Detector Performance Using Image Enhancement Filters,"[2]** considered some techniques of image processing on watermark detection rate. Watermarking methods are highly sensitive to complex degradation attacks such as printscan process or JPEG compression, thus the detection rate of a watermark method decreases

considerably. Unsharp, Laplacian or deconvolution filters are used to reduce the degradation of the image to improve the detection rate. Over 1000 image datasets were used for the experiment which were watermarked and then compressed or scanned and printed. Unsharp, Laplacian and blind deconvolution filters were used to enhance the degraded images.

C. Xiaoying Fang, Jingao Liu, Wenquan Gu, Yiwen Tang ,**" A Method to Improve the Image Enhancement Result based on Image Fusion," [3]** proposed a method to improve the image enhancement result using image fusion method by evaluating the sharpness. In this paper several fusion policies and evaluation methods are discussed and compared.

D. Ching-Tang Hsieh, Eugene Lai, You-Chuang Wang , **"An effective algorithm for fingerprint image enhancement based on wavelet transform,"[4]** proposed an effective algorithm for fingerprint image enhancement, which improves the clarity and continuity of the ridges, based on the multiresolution analysis of local orientation and global texture by the wavelet transform. Experimental results show that this algorithm enhances the image quality better than the existing methods.

E. Wei Wang , Jianwei Li, Feifei Huang, Hailiang Feng , **"Design and implementation of Log-Gabor filter in fingerprint image enhancement ," [5]** introduced Log-Gabor filter to overcome the limitations of traditional Gabor filter and to improve the performance. In fingerprint image filtering, Log-Gabor filter introduces its properties such as orientation selection and frequency selection. An analytic expression for the shape of the Log-Gabor function in the spatial domain cannot be constructed because of the singularity in the log function at the origin. So the filters are constructed in frequency domain. In fact, the original fingerprint image should be transformed to frequency domain. For this, Fourier transform (FT) is applied for the whole image and the filtering is implemented with a bank of Log-Gabor filters in frequency domain. At last, a bank of filtered image can be obtained by applying the inverse Fourier transform (IFT). The pixel values from the filtered images are combined according to the intrinsic properties to construct the enhanced image.

F. S. Hashemi, S. Kiani, N. Noroozi and M. E. Moghaddam, **"An image contrast enhancement method based on genetic algorithm", [6]** proposed an enhancement method based on genetic algorithm. Contrast enhancement plays a basic role in image/video processing. Most commonly used method for image contrast enhancement is Histogram Equalization (HE). But, HE and most contrast enhancement methods may produce un-natural looking images. To overcome such problems, contrast enhancement method based on genetic algorithm is proposed. Along with corresponding operators this method also uses a simple and novel chromosome representation. Experimental results showed that this method makes natural looking images particularly when the dynamic range of input image is high.

G. Agaian, SOS S., Blair Silver, Karen A. Panetta, **"Transform Coefficient Histogram-Based Image Enhancement Algorithms Using Contrast Entropy,",[7]** proposed three methods of image enhancement using contrast entropy: i) logarithmic transform histogram matching, ii) logarithmic transform histogram shifting, and iii) logarithmic transform histogram shaping using Gaussian distributions. These three methods are based on the properties of the logarithmic transform domain histogram and histogram equalization. These algorithms also uses the fact that the relationship between stimulus and perception is logarithmic. It also improves a human visual system-based quantitative measurement of image contrast.

H. Sudharsan Parthasarathy, Praveen Sankaran, **"Fusion Based Multi Scale RETINEX with Color Restoration for Image Enhancement,"[8]** proposed a fusion based approach on Multi Scale Retinex with Color Restoration(MSRCR) for image enhancement. Compared to human visual system camera has lower dynamic range that causes images taken to be extremely dependent on illuminant conditions. This algorithm enhances images that are taken under a wide range of nonlinear illumination. Retinex is one of the enhancement techniques that tries to achieve color constancy. To obtain a net improved image in Multi Scale Retinex(MSR),they average multiple SSR(Single Scale Retinex) images.

I. Adin Ramirez Rivera, Byungyong Ryu, and Oksam Chae, **"Content-Aware Dark Image Enhancement Through Channel Division," [9]** proposed a content-aware algorithm that enhances dark images, sharpens edges, and preserves the smoothness of flat regions. An ad hoc transformation is produced by this algorithm for each image. Thus adapting the mapping functions to each image characteristics to produce the maximum enhancement. These algorithms analyze the contrast of the image in the textured regions and boundary and group the information with common characteristics. The relations are modeled by these groups within the image, from which the transformation functions were extracted. The results are then adaptively mixed, by the human vision system characteristics, to improve the details in the image.

J. Mussarat Yasmin, Muhammad Sharif, Saleha Masood, Mudassar Raza and Sajjad Mohsin ,**" Brain Image Enhancement - A Survey,"[10].** The main purpose of brain image enhancement operation is to analyze the brain images correctly in order to diagnose and examine the diseases and problems. Brain related diseases can be investigated and determined in an efficient manner using brain imaging. The main objective of this survey is to evaluate and discuss about different techniques and approaches proposed in order to handle various brain imaging types. This paper presents a short overview of different methods in brain image enhancement.

III. COMPARISON OF VARIOUS IMAGE ENHANCEMENT TECHNIQUES

Table. 1. Comparative analysis of various image enhancement techniques

S.No	Author and Year	Enhancement Technique/ Algorithm	Domain	Application/ Advantages	Limitations
1	Jucheng Yang 2013	Two stage algorithm with gabor filter	Spatial, Frequency	The ridges and valleys are recovered well.	Computation complexity is high and requires more time.
2	A.Poljicak 2012	Unsharp, deconvolution or Laplacian filter	Spatial, Frequency	JPEG Compression and Print-Scan (PS) process.	Attacks such as median filtering and noise cannot be determined.
3	Xiaoying Fang 2011	Image Fusion	Frequency	All regions in the image are enhanced.	Local feature sharpness is evaluated.
4	Ching-Tang Hsieh 2003	Wavelet Transform	Spatial, Frequency	Improves the quality of image and saves computational time.	More complex
5	Wei Wang 2007	Log-Gabor filter for texture feature extraction	Frequency	Arbitrary bandwidth, it effectively improves the contrast between ridges and valleys.	The filter should be constructed with the same size of the spectrum.
6	Sara Hashemi 2010	Genetic algorithms	Spatial	Makes natural looking images when the dynamic range of input image is high.	___
7	Agaian 2007	Logarithmic transform histogram shifting	Spatial	Alter the spatial histogram of an image to match a uniform distribution.	HE will over enhance the image resulting in an undesired loss of visual data, quality and of intensity scale.
8	S. Parthasarathy 2012	Retinex	Frequency	It does not destroy the parts of image that is not needed, color constancy is achieved.	Sometimes noise is enhanced which leads to high entropy.
9	A. R. Rivera 2012	Content- Aware	Spatial	The appearance of human faces, blue skies with or without clouds is enhanced without introducing artifacts.	Information from the shadowed or dark areas of images that had near-black intensities cannot be recovered.
10	M. Yasmin 2012	Contrast stretching, noise removal	Spatial, Frequency	Enhancement of medical images.	Not practical for 3D medical image enhancement and involves lot of calculations.

IV. CONCLUSION

In this paper, various image enhancement techniques are discussed. Content Aware technique was incapable to enhance the dark areas of image but image fusion technique overcomes this drawback and enhances all regions of an image. The Wavelet Transform is a good technique for the image denoising but the input image will face noise always during image processing. Also the Modern technique Retinex performs much better than Histogram Equalization. So in future, Wavelet Transform can be combined with Retinex or image fusion to improve the image enhancement results.

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