Recital Analysis On Various Image Enhancement Techniques

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Abstract
Image enhancement is a fundamental and very crucial step in image processing. The primary purpose of image enhancement is to process an image and improve the visual quality of the image so that the resulting image is "better" than the original image for specific applications and human spectators. Improvement work includes improving the quality of images for human observation. Many images and even real photos suffer from poor contrast and noise, so it is important to improve contrast for better image quality. This research paper focuses on various image enhancement techniques such as Linear Contrast Stretching, Histogram Equalization (H-Eq), Adaptive H-EQ and Contrast Limited Adaptive Histogram Equalization (CLAHE). The improvement (quality) of the image is identified by comparing the values obtained in PSNR and Entropy.

Keywords
Image enhance, Linear Contrast Stretching, Histogram Equalization(H-Eq), Adaptive H-EQ,CLAHE, PSNR and entropy.

Introduction

To improve image quality and provide better input for image processing, we use image enhancement techniques. Based on this, the enhancement techniques are classified into two types: 1. Spatial domain methods: In this method, the processing is done directly on the image pixels, which in turn leads to the enhancement contrast . 2. Methods in the frequency domain[1]. Spatial domain techniques are generally used to achieve contrast enhancement [3]. In the frequency domain, the term Fourier transform is used. The basic idea of frequency domain techniques is to manipulate transform coefficients for image enhancement [3]. Image quality is enhanced by using enhancement techniques to extract meaningful information from the image. Image processing can be used in all fields of science and engineering.The dynamic high-resolution image includes both dark and light areas. The quality of degraded images can be improved by applying enhancement techniques. The enhancement algorithms that work well in one case may be completely different in another[2]. There are three main image enhancement techniques to improve underwater images. They are: contrast stretching, contrast limited adaptive histogram equalization (CLAHE) and histogram equalization [4]. Histogram adjustment is a commonly used image enhancement technique. Image Enhancement improves the visual quality of images[5]

Literature review

P. Janani , J. Premaladha and K. S. Ravichandran[1] have focused on Spatial Domain and Frequency Domain Enhancement Technique. They have also applied various filters on the image to improve the quality of image. PSNR and MSE were used by the researcher to measure image quality. Bharathi Kumari R, Lalithashree A, Spoorthi S Rao and Vrinda Shetty[2] presented the Logarithmic Transformation, Histogram Processing, Histogram Equalization and Contrast Stretching. Harmandeep Kaur Ranota and Prabhpreet Kaur[6] have worked on image enhancement and showed which technique is better under the which conditions and they firmly believed Despite the effectiveness of each of these algorithms when applied separately, in practice one has to devise a combination of such methods to achieve more effective image enhancement. S A Desai, U S Bhadade[7] shown the experimental results and proved that the novel approach is better than conventional techniques and state of the-art techniques. An image resolution enhancement technique has been proposed in which discrete wavelet transform and stationary wavelet transform have been used. Jinwen Yang, et al.[9], proposed the technology of image enhancement that restored the property of images and compared the pre-processing image with post-processing image. The

experimental results conclude that there may be restore the contrasted effect by using specification and histogram equalization. Tarun kumar, et al[10]., explained the various techniques to pixel conversion of RGB to gray scale image and compared offered equation with the Braum method . P.Janani et. al[11]., briefly discussed about techniques of image enhancement and various noises. Many filters have been used and comparing them to find the best filter by using MSE and PSNR value [11]. M. S. Alkoffash, et al[12], discussed about the digital image processing techniques such as extract the features, image enhancements and image restoration and have main objectives at presenting the recognition of characters in digital images.

Techniques of Image Enhancement

Image enhancement has a great challenge to measure the image quality criterion and hence; different image enhancement techniques are available. Using the image enhancement technique, the image can be adjusted with edge enhancement, grayscale clipping, saturation transformation, hue, intensity and contrast.

Comparison of various Image enhancement techniques

Sr.No.	Name of Techniques	Advantages	Disadvantages
1	**Linear Contrast Stretching** Linear contrast stretching is an image enhancement technique that aims to improve the contrast and visibility of an image by stretching the range of intensity values. It is a simple and commonly used technique in image processing.	It involves scaling the intensity values linearly to a new range. The range of intensity values, it can bring out details and make the image appear visually appealing. The ratio of differences between intensities remains the same, which helps maintain the overall structure and relationships within the image.	Linear contrast stretching has limitations in cases where the image has extreme or non-uniform intensity distributions. Linear contrast stretching can cause a loss of information. Linear contrast stretching amplifies the noise present in an image along with the desired signal. Linear contrast stretching uses a fixed scaling factor for stretching the intensity range.
2	**Histogram Equalizatio(H-Eq)** Histogram Equalization (H-Eq) is an image enhancement technique that redistributes the pixel intensities in an image to achieve a more balanced and enhanced contrast. It works by equalizing the histogram of the image, which represents the frequency distribution of pixel intensities.	By redistributing the intensity values across a wider range, it brings out details and enhances the visibility of both dark and bright areas in the image. Unlike linear contrast stretching, Histogram Equalization adapts to the specific image content and histogram distribution. It maintains the structure and relationships within the image, preventing	Histogram Equalization is less sensitive to noise than some other techniques, it can still amplify noise to some extent. Histogram Equalization operates globally on the entire image, without considering local variations or specific image regions. Implementing Histogram Equalization can be more complex than

		distortion or loss of information.	some simpler enhancement techniques.
3	**Adaptive H-EQ** Adaptive Histogram Equalization (AHE) is an image enhancement technique that improves the contrast of an image by dividing it into smaller regions and performing histogram equalization on each region independently. This allows for adaptive enhancement, where different regions with varying lighting conditions can be treated differently.	AHE operates on smaller regions of the image, which allows for local contrast enhancement. It maintains the relative differences between intensity values within each region, preventing the loss of information or distortion. AHE is effective in handling images with uneven lighting conditions, such as images with strong shadows or highlights.	In certain cases, AHE may lead to over-enhancement or over-saturation of regions with high local contrast. AHE involves dividing the image into smaller regions and performing histogram equalization on each region independently. AHE divides the image into regions or blocks and performs histogram equalization independently on each block.
4	**CLAHE** CLAHE is an image enhancement technique that addresses some of the limitations of standard Adaptive Histogram Equalization (AHE). It employs a contrast limitation mechanism to prevent over-amplification of noise and extreme intensity values.	CLAHE performs local contrast enhancement by dividing the image into smaller regions and equalizing the histograms independently. CLAHE ensures that the contrast enhancement is limited by setting a threshold or maximum value for the intensity values. CLAHE is effective in handling images with uneven lighting conditions, just like AHE. It adaptively enhances each region to compensate for local lighting variations, resulting in a more balanced and visually pleasing image.	CLAHE divides the image into blocks or regions to perform histogram equalization independently. This division can introduce block artifacts, especially when the block size is relatively large. CLAHE requires the selection of parameters, such as the block size, contrast limit, and distribution of tiles. Choosing appropriate parameter values can be challenging and may require experimentation and fine-tuning to achieve desirable results.

			CLAHE involves additional computational steps compared to global histogram equalization techniques. Since CLAHE operates on local regions independently, there is a possibility of losing the global contrast information. This can result in an image that appears visually inconsistent.

Experiments on various Image Enhancement Techniques

Various image enhancement techniques were applied on the sample of image based on the steps each one of them describes. For the analysis purpose, Entropy and PSNR are used to identify which image enhancement technique is the give best result. PSNR stands for Peak signal-to-noise ratio is a technical name used for the relationship between the highest achievable power of the signal and the effect of corrupting noise that affects the reliability of the display. The higher value of PSNR represents the better quality of the compressed or reconstructed image. PSNR is the peak signal-to-noise ratio measure in decibels (Db). The entropy value is derived from the probability distribution of pixel intensities within the image. A higher entropy value indicates greater complexity or randomness in the image, meaning there is a wider range of pixel intensities and less predictability in the image structure.

		
Original Image	Grey Image	Linear Contrast Stretching
		
Histogram Equalizatio(H-Eq)	Adaptive H-EQ	CLAHE

Statistical Analysis based on PSNR and Entropy parameter

Various Image Enhancement Technique	PSNR	Entropy
Linear Contrast Stretching	33.3265 dB	7.8147
Histogram Equalizatio(H-Eq)	21.8540 dB	5.9882
Adaptive H-EQ	18.5292 dB	7.9876
CLAHE	18.3408 dB	7.9895

Conclusion

Image enhancement is the improvement of digital image quality (wanted e.g. for visual inspection or for machine analysis), without knowledge about the source of degradation. In this paper image enhancement techniques like Linear Contrast Stretching, Histogram Equalization(H-Eq), Adaptive H-EQ, CLAHE were reviewed in tabular manner. High PSNR is indicate the quality of your image and Entropy is the basically indicate the contrast of the image. From the experimental calculations presented, we can come to the conclusion that, is Linear Contrast Stretching best for the image enhancement because the value of PSNR is greater than rest of the techniques.

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