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A CRITICAL REVIEW OF DIGITAL IMAGE PROCESSING TECHNIQUES

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ABSTRACT

This paper has focused on the different image enhancement techniques. Image enhancement has found to be one of the most important vision applications because it has ability to enhance the visibility of images. It enhances the quality of poor pictures. Distinctive procedures have been proposed so far for improving the quality of the digital images. To enhance picture quality image enhancement can specifically improve and limit some data presented in the input picture. It is a kind of vision system which reductions picture commotion, kill antiquities and keep up the informative parts. Its objective is to open up certain picture characteristics for investigation, conclusion and further use. The main objective of this paper is to explore and discover the limitations of the existing image enhancement strategies.

KEYWORDS: AHE, CLAHE, Human Visual Perception, Image Enhancement, Visibility

INTRODUCTION

Enhancement is the method of improving the superiority of a digitally stored image. To make an image lighter or darker or to increase or decrease contrast. The sensitivity of information in images is improved by the image enhancement, or to provide enhanced input for other regular image processing techniques. The most essential mean of image enhancement is to convert attributes of an image to making it more suitable for a given task and exacting viewer. During this procedure, one or more attributes of the image are customized.

The option of attributes and the way they are customized are specific to a given task. Image enhancement is the method of adjusting digital images therefore the outcome is more appropriate for show or more study. The enhancement doesn't raise the inbuilt information content of the data, other than it increases the dynamic range of the selected facial appearance as a result that they can be detected simply.

- **Spatial Domain Enhancement Method**

The name domain refers to the collection of pixels composing an image. Spatial domain techniques are procedures that work directly on these composed pixels.

- **Frequency Domain Method**

Frequency domain image enhancement is straightforward. The frequency filters developed an image in the frequency domain. This type filtering technique is very simple.

There are some other enhancements techniques are given as follows:

Contrast Enhancement

The goal of contrast enhancement is to get better visibility of image details without introducing impractical visual appearances and unnecessary artefacts [1]. Contrast enhancement tunes the intensity of each pixels magnitude based on its neighbouring pixels. Contrast enhancement has following techniques:

Brightness Contrast

- **Linear Contrast Stretching**

This also known as normalization, this is the technique for enhancement to improve the contrast of an image by stretching the range of intensity values.

- **Histogram Equalization**

Histogram equalization (HE) is a method for enhancing the contrast and contrast adjustment in image processing [2].

- **Adaptive Contrast Enhancement**

This technique used to overcome the problem of histogram equalization. Adaptive contrast enhancement improved the contrast of an image.

Blur Reduction

Blurriness of image means that image is not seen clearly. Blur reduction is method to remove the blurriness of image and make it clear for visual aspects. Blurriness in image may be due fog, motion, cloud, smudge etc. flowing are method for blur reduction.

- **Image Sharpening**

An image is blurring to some degree when it clicked through digital camera sensors. Image sharpening for emphasizing texture and drawing viewer focus. Unsharp masking is one of the good techniques for image sharpening.

- **Wiener Deconvolution**

Wiener deconvolution work in frequency domain that remove the problem of noise by using wiener filter. Wiener deconvolution used in image deconvolution applications.

Removing Noise

Noise is unwanted signal or undesired variations in image or in colour information in image. Gaussian noise, salt and pepper noise, shot noise, quantization noise, etc. are types of noise in images. Filtering is best method for reducing or removing the noise. Following filters are used basically for removing noise.

- **Linear Filtering**

Linear filter produce the linear output when input is time varying input signal. Linear filtering is relevant to the computer vision. This is suitable for 1D and 2D images.

- **Median Filter**

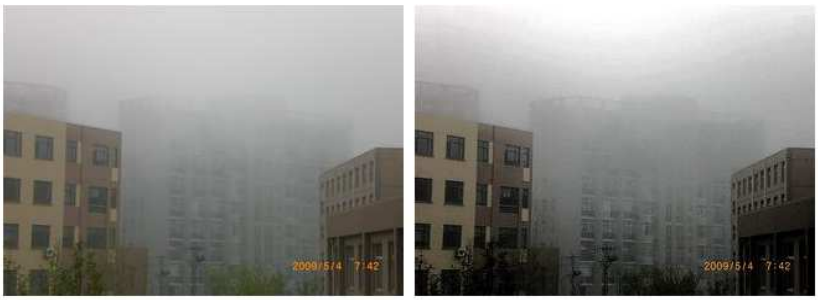
This is a nonlinear approach for noise reduction on an image. The essential part of the median filter is to run the signal entry by entry, replacing all entry with median neighbour entry.

- **Adaptive Filtering**

Adaptive filter a linear filter. In this filtering some variable parameters are controlled by transfer function. Adaptive filters common in mobile phones and other communication devices. Contrast enhancement method is one of efficient method for image enhancement. Histogram equalization is one of the good approaches for enhancing the contrast of the image.

HISTOGRAM EQUALIZATION

Histogram equalization (HE) is a method for enhancing the contrast and contrast adjustment in image processing. This method used in various applications areas such as medical image processing, object tracking, speech recognition etc [2]. Histogram equalization used in the images that are with backgrounds and foregrounds that are both bright or both dark. This method can give the better views of bone structure in x-ray images, and to enhanced detail in photographs.



a) Original Image **b) Output HE**

Figure 1: Results of Histogram Equalization (a) Original Image (b) Output Result of Histogram Equalization (*Adapted from [13]*)

Histogram equalization based contrast enhancement which is in general divided into two parts: global histogram equalization and local histogram equalization. Global histogram equalization based [8] algorithms calculate the cumulative distribution function by using the probability distribution function of the original image, and accomplishes the contrast enhancement by cumulative distribution function mapping. Local histogram equalization based algorithms only balance pixels in the finite region, thus they could efficiently decrease the impact of other regions, and significantly enhance the local details. The general histogram equalization formula is

$$h(v) = round\left(\frac{cdf(v) - cdf_{\min}}{(M \times N) - cdf_{\min}} \times (L-1)\right) \quad (1)$$

Where cdf_{min} is the minimum non-zero value of the cumulative distribution function, M×N gives the image's number of pixels and L is number of gray level used.

ADAPTIVE HISTOGRAM EQUALIZATION

Histogram equalization emphasize only on local contrast instead of overall contrast. Adaptive histogram equalization overcomes from this problem, this technique applicable for overall techniques. Histogram equalization uses

similar transformation resultant from the image histogram to transform all pixels. This works well when the distribution of pixel values is similar throughout the image [3].

a) Original Image **b) Output AHE**

Figure 2: The Results of Adaptive Histogram Equalization (a) Original Image (b) Output Results of Adaptive Histogram Equalization

However when the image contains regions that are extensively lighter and darker, the contrast in those regions will not be adequately enhanced. Adaptive histogram equalization equation computed as If (x, y) is a pixel of intensity i from the image, then we note with $m_{+,-}$ the mapping of right upper $x_{+,-}$,$m_{+,+}$ the mapping of right lower$x_{+,+}$, $m_{-,+}$the mapping of left lower $x_{-,+}$ and $m_{-,-}$ the mapping of the left lower $x_{-,-}$ then

$$m(i) = a[bm_{-,-}(i) + (1-b)m_{+,-}(i)] + [1-a][bm_{-,+}(i) + (1-b)m_{+,+}(i)] \quad (2)$$

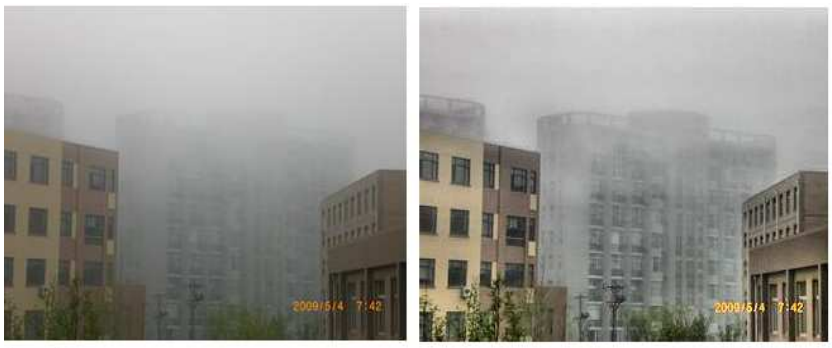
Where

$$a = \frac{y-y_-}{y_+-y_-}, b = \frac{x-x_-}{x_+-x_-}$$

On this by transforming each pixel with a conversion function obtained from a neighbourhood region adaptive histogram equalization improves.

CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION

The methods that prevent the limiting the amplification called contrast limited adaptive histogram equalization. This technique is differing from above in its contrast liming. The contrast limiting procedure has to be applied for each neighbourhood from which a transformation function is derived in contrast limiting adaptive histogram equalization [13].



a) Original Image **b) Output CLAHE**

Figure 3: The Results of Contrast Limited Adaptive Histogram Equalization (a) Output Image (b) Output Result of CLAHE (*Adapted from [13]*)

The contrast amplification in the neighbourhood of a given pixels value is given by the slope of the transformation function. This is proportional to the slope of the neighbourhood cumulative distribution function and therefore to the value of the histogram at the pixel value. The general equation for contrast limited adaptive histogram equalization is

$$N_{aver} = \frac{N_{CR-Xp} \times N_{CR-Yp}}{N_{gray}} \quad (3)$$

Where N_{aver} is average number of pixels, N_{gray} is number of gray level in the contextual region, $N_{CR\text{-}Xp}$ is the number of pixel in the X-dimension in the contextual region, $N_{CR\text{-}Yp}$ is the number of pixel in Y-dimension in the contextual region.

LITERATURE REVIEW

The literature review is to find the benefits of enhancement algorithm and also find the different problems in existing algorithms and techniques. The main goal of this literature review is to find the gaps in existing research and methods and also what will be the possible solutions to overcome these holes.

Shaohua Chen and Azeddine Beghdadi [14] proposed a technique that is encouraged by retinex theory and histogram rescaling techniques, which is natural rendering of colour image based on retinex. Retinex theory is most attractive approaches for image enhancement and colour consistency. It applies five steps of image processing, namely global mapping using a circle function, luminance enhancement using modified one filter retinex, histogram rescaling for luminance channel, a map-based image enhancement and finally a histogram rescaling. The integration of on-filter retinex and histogram rescaling also improves natural appearances of image.

Zhiyuan xu [13] give a method for images that have poor contrast due to fog or for any other reason. Contrast limited adaptive histogram equalization method has been limited the noise and enhancing the image contrast. According the method original image converted into the RGB to HIS and then processed by CLAHE. The resultant image shows significant improvement in fog degraded images. On the comparison with other method, this method is simple and faster.

Sangjin Kim et al. [12] presented a approach for overcoming the traditional noise reduction method have a tendency restrain high-frequency details problem by using wavelet-domain colour image enhancement using filtered directional bases and frequency- adaptive shrinkage. First remove the noise from flat as well as edge regions. Wavelet basis and Gaussian low pass filters has used for directional transform. This framework reduces the noise without losing sharp details. This approach suits for real time application.

Wei-Ming ke et al. [11] This provide there are so many types of image enhancement techniques that makes the image results better that associate to the person visual system. It includes the two techniques bilateral tone Adjustment and Saliency Weighted Contrast Enhancement both combined in image enhancement framework. The saliency-weighted Contrast enhancement integrates the notion of image saliency into an easy filter-based contrast enhancement technique. By using the luminance component in this saliency weighted contrast enhancement achieves extra performance. It proved that to achieve higher contrast enhancement with slight sound and huge image quality.

Hasan Demirel et al. [10] proposed the important quality factor in satellite images comes from its contrast. The new satellite image contrast enhancement technique that is based on the discrete wavelet transform and singular value decomposition. The method has compared with conventional image equalization methods like standard general histogram

equalization and local histogram equalization, as well as state-of-the-art method such as brightness preserving dynamic histogram equalization and singular value equalization. The visual results on the image quality showed the advantage over the other methods. Bin Liu et al. [9] discussed that the image contains information that is sometime not clear for human. Enhancement not only enhances the details that hidden in the scene and increases the recognition of interested targets. For executing the histogram projection independently contrast enhancement segmented into the sub-blocks. It enhanced the local details and conserve image brilliance to avoid blocking effect and wash-out effect. It has effective, efficient and flexible.

Chelsy sapna et al. [8] proposed a method that removed the limitation of amplification of speckle noise that loss the information from the image in adaptive histogram equalization. The combination of frost filter and median filter on contrast limited adaptive histogram equalization images used. It has been mainly focused on medical images. Its helps to remove the speckle noise and give better output.

Omar S. Soliman and Amira s. Mahmud [7] demonstrate the classification for remote sensing images has one of the most important applications in spatial data mining. Remote sensing advanced space borne thermal emission and reflection radiometer satellite imagery using support vector machine with non-linear kernel function has classification system. Image segmentation is done by the threshold algorithm and extracted by object based algorithm. The performance gave the highest overall accuracy.

Amina saleem et al. [6] proposed a method that balances the condition of local and global contrast enhancements and a realistic representation of the original image and overcome the restrictions of different contrast enhancement that is fusion-based contrast enhancement algorithms. By using Laplacian pyramid decomposition a technique has used for fusion. The results show that enhancing the local and global contrasts.

Mohd.Farhan khan et al. [5] proved that the contrast enhancement histogram equalization is an efficient method but it’s not efficient for preserving the mean brightness of images. To overcome this problem weighted average multi segment histogram equalization method is proposed by using Gaussian filter for contrast enhancement of natural images. Weighted average multi segment histogram equalization give better results rather than multi-histogram equalization method when contrast enhancement along with brightness preservation is desired and also reduce the effect of noise that is present in the image.

E.ullah et al. [4] give a technique for dark channel that raise the superiority of image. Environmental effects degrade the image quality, these effects like haze, fog, snow, etc. light is spread out when it propagates through the water droplet that is in atmosphere that loss the quality of image. The present work has been used the dark channel prior technique for dehazing. The model used the HIS colour model is intuitive based on the intensity and saturation components of the foggy pixels.

Thien Huynh and Thuong Le-Tien [3] give a technique for preserving the intensity and visual artefacts. For sorting out the original histogram, intensity preserving weighted dynamic range histogram equalization used in class variance. The method focus on separating point based on variance to minimize the squared error of sub-histogram corresponding to brightness shift with histogram equalization. The result has shown enhanced the contrast and also preserves the brightness. Results proved the method better than others methods in overall brightness, the discrete entropy, the local contrast.

Adela Raju et al. [2] demonstrate for preserving the brightness and contrast enhancement of an image clipping and plateau histogram equalization methods. Self-adaptive plateau histogram equalization takes the threshold level by self that impossible in clipping and plateau histogram equalization. Self-adaptive plateau histogram equalization method is complicated and sometimes fails in execution. To overcome above problem modified self adaptive plateau histogram equalization with mean threshold used. To overcome the self-adaptive plateau histogram method problems and also detect the local maximum and global maximum but, instead of median threshold value, mean threshold value is used for histogram modification. It enhances the image without introducing unwanted artefacts and gives better contrast enhancement and brightness preserving.

Eunsung Lee et al. [1] discuss the problem that are arises due to the histogram equalization, problem like histogram equalization approaches degrade the image quality by exhibiting saturation artefacts in both low and high intensity regions present the algorithm computes brightness based on adaptive intensity transfer function that uses the low frequency luminance component in the wavelet domain and transforms intensity values according to the transfer function. Discrete wavelet transfer applies on the input images.

GAPS IN EXISTING LITERATURE SURVEY

Following are the major disadvantages that are found in the related work of image enhancement techniques**.**

- The survey has found that the most existing techniques are based upon the transform domain methods, which may introduce the colour artefacts.
- Transform domain method may reduce the intensity of the input remote sensing image.
- The use of dark channel and CLAHE in algorithm ignored by many researchers to reduce the problem of poor brightness which will be presented in the output image due to dominant level.

CONCLUSIONS AND FUTURE SCOPE

The image enhancements techniques have played a significant role in digital vision processing. This paper shows that the image enhancements have successfully used to improve the quality of a poor intensity images by using the concept of the light source refinement. The survey has found that the most existing techniques are based upon the transform domain methods, which may introduce the colour artefacts.

In near future we will use a modified image enhancement model to enhance the limitations of earlier work.

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