Linear and Non-linear Contrast Enhancement Image

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Abstract
This paper attempts to undertake the study two types of the contrast enhancement techniques, linear contrast techniques and non-linear contrast techniques. In linear contrast techniques applying three methods, Max-Min contrast method, Percentage contrast method and Piecewise contrast technique. Non-linear contrast techniques applying four contrast methods, Histogram equalization method, Adaptive histogram equalization method, Homomorphic Filter method and Unsharpe Mask. in the Homomorphic Filter method applying by using two type of filter, Low Pass Filter(LPF)and High Pass Filter(HPF).this applying to choose the base guesses for contrast enhancement image.

Keywords:
Linear contrast enhancements; Non-Linear contrast enhancements

1. Introduction

One of the most important quality factors in satellite images comes from its contrast. Contrast enhancement is frequently referred to as one of the most important issues in image processing. Contrast is created by the difference in luminance reflected from two adjacent surfaces. To this cause more studies take this subject which we can brief some of this: Local contrast stretching (LCS) is an enhancement method performed on an image for locally adjusting each picture element value to improve the visualization of structures in both darkest and lightest portions of the image at the same time. LCS is performed by sliding windows (called the KERNEL) across the image and adjusting the center element [1]. Partial contrast is an auto scaling method. It is a linear mapping function that is usually used to increase the contrast level and brightness level of the image. This technique will be based on the original brightness and contrast level of the images to do the adjustment. Dark stretching is known as part of partial contrast stretching, dark stretching is a reverse process of bright stretching process .Bright stretching is a process that also used auto scaling method which is a common linear mapping function to enhance the brightness and contrast level of an image [2].Image histogram is a powerful engineering tool to portray information of an image. It can be used to provide solutions to improve quality control, but again has never been used on improving the high quality of an image. Some of the improved techniques of histogram equalization with brightness preserving include the bi-histogram equalization (BHE) [3].Histogram equalization is the most popular algorithm for contrast enhancement due to its effectiveness and simplicity. It can be classified into two branches according to the transformation function used: global or local. Global histogram equalization is simple and fast, but its contrast-enhancement power is relatively low. Local histogram equalization, on the other hand, can enhance overall contrast more effectively, but the complexity of computation required is very high due to its fully overlapped sub-blocks [4].Global histogram equalization method is simple and powerful, but it cannot adapt to local brightness features of the input image because it uses only global histogram information over the whole image. This fact limits the contrast-stretching ratio in some parts of the image, and causes significant contrast losses in the background and other small regions. To overcome this limitation, a local histogram-equalization method has been developed, which can also be termed block-overlapped histogram equalization [5].We analyzed a Landsat-MSS image from Peruvian Amazona to find out which methods of digital image processing give the most useful results for detecting and delimiting different vegetation types and geological formations. The best results were obtained with enhanced colour composites,

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especially when histogram equalization was applied: the vegetation types that were known from the area were clearly visible in the image products, and also previously unknown regional patterns were found [6].Most conventional contrast enhancement algorithms usually fail to provide detailed contrast information in the dark and bright areas of remotely sensed images. This study proposed a fuzzy-based approach to enhance all the contrast and brightness details of the image. The test results indicate that the proposed method could provide better contrast image than the conventional enhancement methods in terms of visual looks and image details [7].Homomorphic filter approach for image processing is very well known as a way for image dynamic range and increasing contras.homomorphic filter has several useful properties in remote sensing image enhancement applications. According to this approach, input signal is assumed to consist of two multiplicative components: background and details. The standard problem in processing such signals involves logarithm operation, division on two components by implementing low frequency and high-pass filters, addition of evaluations multiplied by different gain coefficients, and exponent calculation. It was found that the proposed homomorphism filter has several useful properties in remote sensing image enhancement applications [8].

2. Contrast

One of the most important quality factors in satellite images comes from its contrast. Contrast enhancement is frequently referred to as one of the most important issues in image processing. Contrast is created by the difference in luminance reflected from two adjacent surfaces. In visual perception, contrast is determined by the difference in the color and brightness of an object with other objects. Our visual system is more sensitive to contrast than absolute luminance; therefore, we can perceive the world similarly regardless of the considerable changes in illumination conditions. If the contrast of an image is highly concentrated on a specific range, the information may be lost in those areas which are excessively and uniformly concentrated. The problem is to optimize the contrast of an image in order to represent all. Sometimes during image acquisition low contrast may be result due to one of the following reasons: poor illumination, lack of dynamic range in the image sensor and wrong setting of the lens aperture. The idea behind contrast stretching is to increase the dynamic range of gray levels in the image being processed. Linear and nonlinear digital techniques are two widely practiced methods of increasing the contrast of an image.

2.1 Linear contrast enhancement

This type referred a contrast stretching, linearly expands the original digital values of the remotely sensed data into a new distribution. By expanding the original input values of the image, the total range of sensitivity of the display device can be utilized. Linear contrast enhancement also makes subtle variations within the data more obvious. These types of enhancements are best applied to remotely sensed images with Gaussian or near-Gaussian histograms, meaning, all the brightness values fall within a narrow range of the histogram and only one mode is apparent. There are three methods of linear contrast enhancement:

2.1.1 Min-Max Linear Contrast Stretch

When using the minimum-maximum linear contrast stretch, the original minimum and maximum values of the data are assigned to a newly specified set of values that utilize the full range of available brightness values. Consider an image with a minimum brightness value of 45 and a maximum value of 205. When such an image is viewed without enhancements, the values of 0 to 44 and 206 to 255 are not displayed. Important spectral differences can be deselected by stretching the minimum value of 45 to 0 and the maximum value of 120.this method is applying with respect to image application type**.**

g(x, y)=(f(x,y)-min)/(max-min))*No. of the intensity level (1)

where, g(x,y) represents the images, on the left side it represents the output image, while f(x,y) it represents input image. In this equation the "min" and "max" are the minimum intensity value and the minimum intensity value in the current image. Here "no. of intensity levels" shows the total number of intensity values that can be assigned to a pixel. For example, normally in the gray-level images, the lowest possible intensity is 0, and the highest intensity value is 255. Thus "no. of intensity levels" is equal to 255.

2.1.2 Percentage Linear Contrast Stretch

The percentage linear contrast stretch is similar to the minimum-maximum linear contrast stretch except this method uses specified minimum and maximum values that lie in a certain percentage of pixels from the mean of the histogram. A standard deviation from the mean is often used to push the tails of the histogram beyond the original minimum and maximum values.

2.1.3 Piecewise Linear Contrast Stretch

When the distribution of a histogram in an image is bi or remodel, an analyst may stretch certain values of the histogram for increased enhancement in selected areas. This method of contrast enhancement is called a piecewise linear contrast stretch. A piecewise linear contrast

enhancement involves the identification of a number of linear enhancement steps that expands the brightness ranges in the modes of the histogram.
This type can be expressed by:

$$f(x, y) = \begin{cases} ax, & 0 \le x \le x_1 \\ b(x - x_1) + y_{x_1}, & x_1 \le x \le x_2 \\ c(x - x_2) + y_{x_1}, & x_2 \le x \le B \end{cases} \quad (2)$$

Where: f(x, y) is the Piecewise Linear Contrast Stretch in the image, a, b, and c are appropriate constants, which are the slopes in the respective regions and B is the maximum intensity value.

2.1 Nonlinear Contrast Enhancement

Nonlinear contrast enhancement often involves histogram equalizations through the use of an algorithm. The nonlinear contrast stretch method has one major disadvantage. Each value in the input image can have several values in the output image, so that objects in the original scene lose their correct relative brightness value. There are three methods of nonlinear contrast enhancement:

2.2.1 Histogram Equalizations

Histogram equalization is one of the most useful forms of nonlinear contrast enhancement. When an image's histogram is equalized, all pixel values of the image are redistributed so there are approximately an equal number of pixels to each of the user-specified output gray-scale classes (e.g., 32, 64, and 256).Contrast is increased at the most populated range of brightness values of the histogram (or "peaks"). It automatically reduces the contrast in very light or dark parts of the image associated with the tails of a normally distributed histogram . Histogram equalization can also separate pixels into distinct groups, if there are few output values over a wide range. histogram equalization is effective only when the original image has poor contrast to start with, otherwise histogram equalization may degrade the image quality. to this case the adaptive histogram equalization is improve this case.

2.2.2 Adaptive Histogram Equalization

Adaptive histogram equalization where you can divide the image into several rectangular domains, compute an equalizing histogram and modify levels so that they match across boundaries. Depending on the nature of the non-uniformity of the image.
Adaptive histogram equalization uses the histogram equalization mapping function supported over a certain size of a local window to determine each enhanced density value. It acts as a local operation. Therefore regions occupying different gray scale ranges can be enhanced simultaneously.
The image may still lack in contrast locally. We therefore need to apply histogram modification to each pixel based on the histogram of pixels that are neighbors to a given pixel. This will probably result in maximum contrast enhancement. According to this method, we partition the given image into blocks of suitable size and equalize the histogram of each sub block. In order to eliminate artificial boundaries created by the process, the intensities are interpolated across the block regions using bicubic interpolating functions.

2.2.3 Homomorphic Filter

Homomorphic filter is the filter which controls both high-frequency and low-frequency components .homomorphic filtering aims at handling large of image intensity, it has a multiplicative model .When images are acquired by optical means, the image of the object is a product of the illuminating light source and the reflectance of the object, as described by:

$$f(x, y) = I(x,y)\,\rho\,(x,y) \quad (3)$$

Where I is the intensity of the illuminating light source, f is the image, and
$0 \le \rho \le 1$ is the reflectance of the object.
In order to enhance an image with poor contrast, we can use the model and selectively filter out the light source while boosting the reflectance component.
The result will be an enhancement of the image. In order to separate the two components, they must be additive.
We therefore transform the image into the log domain, whereby the multiplicative components become additive, as

$$\mathrm{Ln}\,(f) = \ln\,(I) + \ln\,(\rho) \quad (4)$$

Since the natural logarithm is monotonic, ln (I) is low pass and ln (ρ) is high pass. Now we have an image $f' = \ln(f)$, which has additive components and can therefore be selectively filtered by a linear filter.
In order to enhance an image, the homomorphic filter must have a higher response in the high-frequency region than in the low-frequency region so that the details, which fall in the high frequency region, can be accentuated while lowering the illumination component.

2.2.4 Unsharpe Mask

The unsharp mask method is the technique to increase the sharpness in the image contrast.unsharp masking can be expressed by:

$$y(m,n) = f(m,n) + a*g(m,n) \quad (5)$$

Where:

f is the input image,y is the sharpened image and g is the gradient image.a is the contrast constant greater than zero.

3. Experiments Verifications

3.1 Testing Procedure

The contrast stretching was implemented using (MATLAB R2007a, 7.4a) and tested two types of contrast enhancement, Linear Contrast and Non-Linear Contrast on the image illustrated in the figure (1)

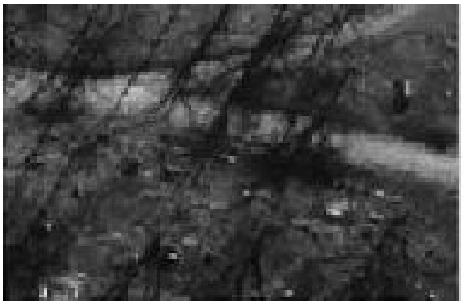

Fig-1 Contrast Image

Three methods of linear contrast enhancement techniques are implemented:
Minimum-Maximum Linear Contrast Stretch (MMLC), Percentage Linear Contrast Stretch (PLC) and Piecewise Linear Contrast Stretch (PWLC).
Three methods of non-linear contrast enhancement techniques are implemented: Histogram Equalizations (HE), Adaptive Histogram Equalization (AHE) and Homomorphic Filters (HF).The homomorphic are implemented by two of filters: Low Pass Filter (LPF) and High Pass Filter (HPF).

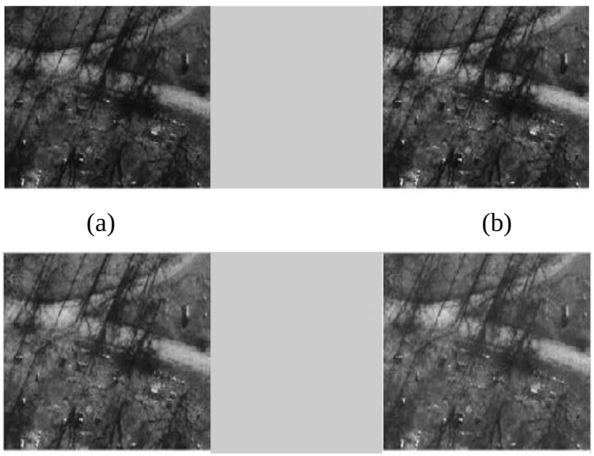

Fig-2 Linear Techniques (a) Original Image (b) Max-Min Contrast Enhancement (c) Percentage Contrast Enhancement (d) Piecewise Contrast Enhancement.

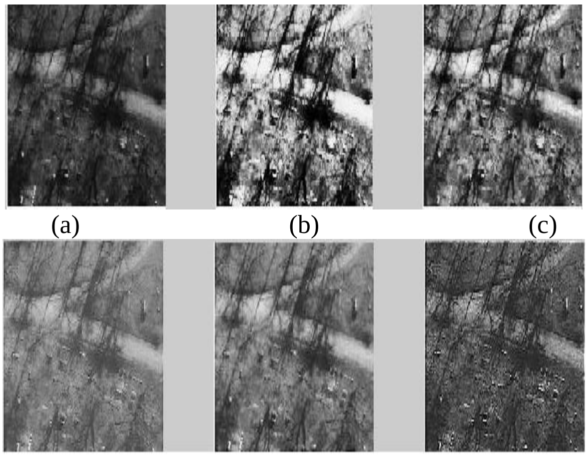

Fig-3 Nonlinear Techniques (a) Original Image Contrast (b) Histogram Equalization Contrast Enhancement(c) Adaptive Histogram Equalization (d) LPF Homomorphic Contrast Enhancement (e) HPF Homomorphic Contrast Enhancement (f) Unsharp Mask Contrast Enhancement.

3.2 Simulation Results

Intensive simulations were carried out using one monochromes satellite images are chosen for demonstration. the performance evaluation of contrast enhancement are appearing the Piecewise Contrast Enhancement is the best methods in the linear techniques of contrast enhancement and not bad to using another methods.HPF and LPF homomorphic methods is best methods of nonlinear techniques. But the nonlinear techniques are appearing more effective in contrast processing from linear techniques.

4. Conclusion

In this paper, the comparative studies take three cases: the first case comparative between the linear contrast methods, second case comparative between the non-linear contrast methods and third case comparative between two methods linear and non-linear contrast methods. in first case a comparative studies are explained & experiments are carried out for different techniques Max-Min contrast method, percentage contrast methods and *Piecewise* contrast method ,the best techniques to linear contrast enhancement of image sensing is *Piecewise* contrast method see this in the figure(2). But second case of the comparative study is explained & experiments are carried out for different techniques HPF and LPF Homomorphic methods respectively is best methods of nonlinear techniques see in the figure (3). In the third case the study is the best techniques for processing remote sensing image contrast is the non-linear contrast enhancement see the result in the figure (2) and (3).

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