SURVEY OF IMAGE CONTRAST ENHANCEMENT METHODS

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ABSTRACT

Contrast enhancement is fundamental steps in Display of digital images. And design of effective contrast enhancement requires understanding of human brightness perception. This paper attempts to undertake the study of different type of contrast enhancement techniques. Broadly categorized in linear and non linear contrast enhancement techniques. In the linear contrast enhancement applying the max-min contrast methods, percentage contrast methods and piecewise contrast methods. Non linear contrast method applying the histogram equalization methods, Adaptive histogram equalization method, Homomorphic Filter method and Unshaped Mask, Genetic algorithm methods, The Survey of different techniques will lead to help contrast related problem in digital image processing and will be applied accordingly to improve the contrast accordingly.

KEYWORDS: Contrast enhancement, Histogram, Homomorphic filter; Linear and non linear image enhancement methods

INTRODUCTION

One of the most important quality factors in satellite images and medical 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. 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 [1] in both darkest and lightest portions of the image at the same time. Partial contrast is a linear mapping function that is usually used to increase the contrast level and brightness level of the image. 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. Histogram equalization [3] 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. Most conventional contrast enhancement algorithms usually fail to provide detailed contrast information in the dark and bright areas of remotely sensed images. Hence in this survey paper we will use genetic algorithm 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. Homomorphic filter approach for image processing is very well known as a way for image dynamic range and increasing contrast.

The homomorphic filter method for non-linear enhancement in conjunction with conventional wavelet processing technique. Since the histogram distribution in mammography image are concentric the homomorphic filtering leads to the contrast stretching into the lower gray levels thereby enhancing the contrast. The homomorphic filter gives varying gains to wavelet channels so that the contrast of the tumor mass is improved. All the above methods has been tested and results has obtained for different type of images. At last evolutionary Genetic algorithm is used for contrast enhancement for same type of the images and results has been observed.

**CONTRAST**

Contrast enhancement is frequently referred to as one of the most important issues in image processing. 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.

**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, measurement method.

**Minimum-Maximum 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 detected by stretching the minimum value of 45 to 0 and the maximum value of 120 to 255.

\[ g(x, y) = \frac{(f(x, y) - \text{min})}{(\text{max} - \text{min})} \times \text{No. of the intensity level} \] (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.

**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.

**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 express by

$$
f(x, y) = \begin{cases} 
ax, & 0 \leq x \leq x_1 \\
by_1 + x_1, & x_1 \leq x \leq x_2 \\
c(x-x_2) + y_2, & x_2 \leq x \leq B 
\end{cases}
$$

(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.

**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 five methods of nonlinear contrast enhancement.

**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. In this case, the adaptive histogram equalization is improve this case.

**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.

**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:

\[ f(x, y) = I(x,y) \cdot \rho(x,y) \]

(3)

Where \( I \) is the intensity of the illuminating light source, \( f \) is the image, and \( 0 \leq \rho \leq 1 \) 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

\[ \ln(f) = \ln(I) + \ln(\rho) \]

(4)

Since the natural logarithm is monotonic, \( \ln(I) \) is low pass and \( \ln(\rho) \) 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.
GENETIC ALGORITHM

A method to enhance the contrast of genetic algorithm that measures the fitness of individual by evaluating the intensity of spatial edges included in the images. By ability of genetic algorithm to search a solution in a global space a relation between input grey levels and output grey levels is determined to convert an original gray image to an enhanced image with a good contrast. Applying of genetic algorithm to a image consist of the representation of individual chromosome, the genetic operation like reproduction, mutation, crossover and finally selecting the best fitness values of individuals.

EXPERIMENTAL VERIFICATIONS

The Contrast stretching was implemented on matlab and results are tested for various images for contrast enhancements and results are obtained for linear and non-linear contrast enhancement.

The Original satellite image is taken below for experimental results.

![Image](image.jpg)

**Fig:1 The Original 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).

(a) ![Image](image.jpg) (b) ![Image](image.jpg)

(c) ![Image](image.jpg) (d) ![Image](image.jpg)

**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 (g) Genetic Algorithm Enhancement method
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 and Genetic algorithm is best methods of nonlinear techniques. But the nonlinear techniques are appearing more effective in contrast processing from linear techniques.

CONCLUSIONS

In this paper survey has been carried out for linear and non linear contrast enhancement and results has been obtained for satellite images . In Linear enhancement Piecewise contrast enhancement is best method among other existing linear methods.In Non- linear Contrast enhancement method HPF and LPF Homomorphic filter method and Genetic algorithm respectively is best methods. But overall nonlinear techniques appeared to be more effective then linear contrast methods.Further scope of survey can done by adding other methods using neural network, fuzzy logic, wavelet transform which can give more accurate idea of effective contrast enhancement.

REFERENCES


