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A New Method for Improving Contrast Enhancement in Remote Sensing Images by Image Fusion

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***Abstract*— Linear contrast enhancement, conjointly referred to as a contrast stretching, linearly expands the original digital values of the remotely detected data into a new distribution. By increasing the original input values of the image, the entire range of sensitivity of the display device is used. Linear contrast enhancement conjointly makes refined variations among the information more obvious. These kinds of enhancements are best applied to remotely sensed images with Gaussian or near-Gaussian histograms, meaning, all the brightness values fall among a narrow range of the histogram and only one mode is apparent. Image enhancement is the indispensable features in image processing to extend the contrast of the remote sensing data and to provide better transform representation of the remote image data. This paper presents a new methodology to enhance the contrast and intensity of the image data using image fusion with Gaussian and Laplacian pyramid.**

***Keywords*—contrast enhancement, image fusion, pyramidal image composition and decomposition, Gaussian pyramid composition and decomposition.**

I. INTRODUCTION

The principal objective of image enhancement is to process a given image so that the result is more appropriate than the original image for a particular application. It accentuates or sharpens image features like edges, boundaries, or contrast to make a graphic display more useful for display and analysis. The enhancement does not increase the inherent information content of the data, however it increases the dynamic range of the chosen features so that they may be detected simply. The greatest issue in image enhancement is quantifying the criterion for enhancement and, therefore, a large range of image enhancement techniques are empirical and need interactive procedures to get satisfactory results. Image enhancement strategies may be based on either spatial or frequency domain techniques.

A. Image Enhancement Techniques

Image enhancement techniques improve the quality of an image as perceived by an individual's. These techniques are most useful because several satellite images once examined on a color display give inadequate information for image interpretation. There is no conscious effort to enhance the fidelity of the image with respect to some ideal type of the image. There exists a large type of techniques for improving image quality. The contrast stretch, density slicing, edge enhancement, and spatial filtering are the more commonly used techniques. Image enhancement is attempted when the image is corrected for geometric and radiometric distortions. Image enhancement strategies are applied individually to every band of a multispectral image. Digital techniques have been found to be most satisfactory than the photographic technique for image enhancement, due to the precision and wide variety of digital processes.

I. Contrast

Contrast usually refers to the difference in luminance or grey level values in an image and is a vital characteristic. It may be outlined as the ratio of the maximum intensity to the minimum intensity over an image.

Contrast ratio contains a strong bearing on the resolving power and detectability of an image. Larger this ratio, easier it is to interpret the image. Satellite images lack adequate contrast and need contrast improvement.

II. Contrast Enhancement

Contrast enhancement techniques expand the range of brightness values in an image therefore the image may be efficiently displayed in a manner desired by the analyst. The density values in a scene are actually pulled farther apart, that is, expanded over a greater range. The impact is to increase the visual contrast between two areas of assorted uniform densities. This allows the analyst to discriminate easily between areas initially having a small difference in density.

III. Linear Contrast Stretch

This is the best contrast stretch algorithm. The gray values among the original image and the modified image follow a linear relation throughout this algorithm. A density number among the low range of the original histogram is assigned to extremely black and a value at the high end is assigned to extremely white. The remaining picture element values are distributed linearly between these extremes. The features or details that were obscure on the original image will be clear within the distinction stretched image. To produce best contrast and color variation in color composites the small vary of gray values in every band is stretched to the full brightness range of the output or display unit.

IV. Non-Linear Contrast Enhancement

In these methods, the input and output data values follow a non-linear transformation. The general form of the non-linear contrast enhancement is outlined by y = f (x), wherever x is the input data value and y is the output data value. The non-linear contrast enhancement techniques are found to be helpful for enhancing the color contrast between the nearly classes and subclasses of a main class. A form of nonlinear contrast stretch involves scaling the input data logarithmically. This enhancement has greatest impact on the brightness values found at intervals the darker part of histogram. It may be reversed to enhance values in brighter part of histogram by scaling the input data using an inverse log function.

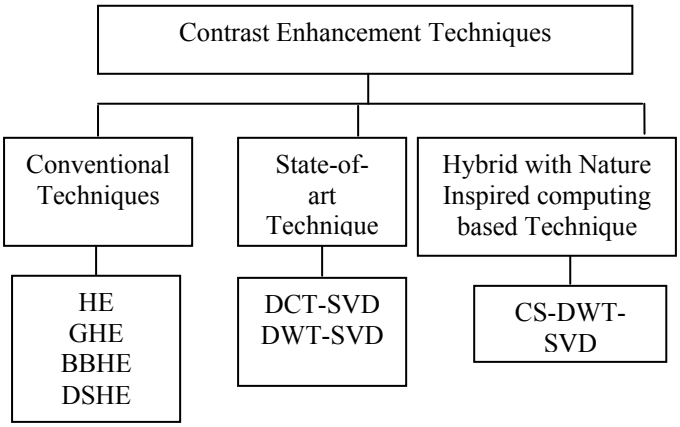

Fig. 1 Chart of Contrast Enhancement

II. LITERATURE REVIEW

In order to understand optimum fusion results, different wavelet-based fusion schemes had been tested by many researchers. Throughout this review, some of latest concepts/algorithms of the upper than methods are mentioned.

A. Intensity-hue-saturation (IHS) Tran- type primarily based fusion

It is an improved Intensity-Hue-Saturation methodology for IKONOS Image Fusion. This technique is used in many applications of remote sensing involves the fusion of panchromatic (Pan) and multispectral (MS) satellite images. The fusion of a panchromatic (Pan) image with a high special and low spectral resolution or multispectral (MS) images with an occasional special and high spectral resolution has become a sturdy tool in many remote sensing applications that require every high spatial and high spectral resolution, like feature detection, modification looking, urban analysis, land cowl classification, and recently GIS-based applications.

In general, the IHS fusion based mostly converts a color image from the red, green, and blue (RGB) space into the IHS color area. The intensity (I) band inside the IHS space is replaced by a high-resolution Pan image thus remodelled back to the primary RGB area at the aspect of the previous hue (H) band and thus the saturation (S) band, resulting in an IHS coalesced image. however the IHS methodology are usually merely enforced by the procedure throughout that the fused footage are usually obtained by adding the distinction image between Pan and that I images to the MS images, severally. This technique is termed the short IHS fusion methodology.

Steps for obtaining IHS work fusion image:

•The IHS fusion for each part are usually developed.

•The intensity part I is replaced by the Pan image.

•The coalesced image [F (R); F (G); F (B)] T are usually merely obtained from the primary image [R; G; B] T simply by exploitation addition operations.

B. Principal Component Analysis (PCA) based fusion

PCA might be a mathematical tool that transforms type of connected variables into type of unrelated variables. The PCA is utilized extensively in compression and image classification. The PCA involves a mathematical procedure that transforms kind of connected variables into selection of unrelated variables referred to as principal components. It computes a compact and optimum description of the information set. In [7], exploitation PCA algorithmic program, color parts are thought of as choices from that a representative set springs. This method is used to chop back selection the number of parts to slightly number of parts supported the individual weights of the corresponding Eigen values. Associate elliptical model classifier is used for classification of skin and non-skin pixels for skin detection. For face recognition, the mandatory step is to choose the choices [8]. The foremost extensively used classifier is principal half analysis that serves two purposes: feature extraction and classification or recognition. It's one in each of the extensively used classifiers that has low time quality. Feature extraction from human faces exploitation PCA [9], proposes facial feature extraction step before taking part in PCA analysis that helps to handle a pair of desires for this method. Firstly, seek for faces does not have to be compelled to be disbursed at every part location inside the image since slightly search space are usually obtained exploitation the detected facial feature points. Secondly, the face detection methodology is usually disbursed in one cycle over a normalized search space, thereby avoiding the necessity of method the image at multiple scales.

C. Multi Scale transform based mostly Fusion Brovey transform

Pixel level image fusion is finished by exploitation Brovey transform. Brovey per-forms a change part three multispectral and thus the panchromatic satellite image scene channels. Brovey process is additionally referred to as the colour standardisation work as a result of it involves a red-green- blue (RGB) color transform methodology. The Brovey transformation was developed to avoid the disadvantages of the increasing methodology. It's a straightforward method-ology for combining info from utterly completely different sensors. It a mixture of arithmetic operations and normalizes the spectral bands before they are redoubled with the panchromatic image. It retains the corresponding spectral feature of each part, and

transforms all the luminousness info into a panchromatic image of high resolution.

D. High-Pass Filtering

High-pass and low-pass filters are used in digital image method to perform image modifications, enhancements, noise reduction, etc., exploitation designs exhausted either the spatial domain or the frequency domain. A high-pass filter, if the imaging package does not have, one are usually done by duplicating the layer, putting a Gaussian blur, inverting, therefore combination with the primary layer exploitation capability (say 50%) . The unsharp masking, or sharpening, operation used in image writing computer code may be a high-boost filter, a generalization of high- pass filtering theme.

E. Image Pyramid Approaches

An image pyramid consists of a collection of low pass or band pass copies of an image, each copy representing pattern information of a unique scale. Typically, in an image pyramid every level may be an issue a pair of smaller as its predecessor, and thus the upper levels will target the lower spatial frequencies. An image pyramid can contain all the information needed to reconstruct the primary image.

1. Gaussian Pyramid

The scientist pyramid consists of low-pass filtered, reduced density (i.e., down sampled) mathematician of the preceding level of the pyramid, where very cheap level is defined as a result of the first image. The technique involves creating a series of images that are full employing a mathematician average and scaled down. Once this method is used multiple times, it creates a stack of successively smaller images, with each part containing a neighbourhood average that corresponds to a part neighbourhood on a lower level of the pyramid.

2. Laplacian Pyramid Fusion

Laplacian pyramid (fundamental tool in image processing) of an image might be a collection of band pass images; throughout that everyone could be a band pass filtered copy of its precursor. Band pass copies are usually obtained by calculative the excellence between low pass images at serial levels of a Gaussian pyramids. Throughout this approach, the Laplacian pyramids for each image part (IR and Visible) are used. A strength live is used to work out from that provide what pixels contribute at each specific sample location. Take the common of the two pyramids like each level and add them. The following image is simple average of two low resolution images at each level. Secret writing of a picture is finished by increasing, then summing all the degree of the fused pyramid that's obtained by straightforward averaging. The Laplacian pyramid comes from the Gaussian pyramid illustration, that's for the most part a sequence of additional and additional filtered and down- sampled versions of a picture. The strategy of face detection is accomplished by exploitation straightforward and economical algorithmic program for multi-focus image fusion called Laplacian pyramid algorithmic program. Multi-resolution signal decomposition theme is efficiently used for any applications like gestures, texture, produce and lighting conditions whereas taking a picture [1]. A kind of fusion approach is very helpful for applications like Hand Gesture. Hand gestures play a significant role in Human computer Interaction. They function primary interaction tools for gesture primarily based laptop management [2].

F. Fusion in Wavelet Domain

Wavelet transform is considered as an alternate to the short time Fourier transforms. It's advantageous over Fourier transform during this it provides desired resolution in time domain nevertheless as in frequency domain whereas Fourier work offers an honest resolution in only frequency domain. In Fourier transform, the signal is decomposed into sine waves of varied frequencies whereas the wavelet transform decomposes the signal into scaled and shifted varieties of the mother wavelet or function. At intervals the image fusion exploitation ripple work, the input images are rotten into approximate and informative coefficients exploitation DWT at some specific level. A fusion rule is applied to combine these two coefficients and so the resultant image is obtained by taking the inverse wavelet work [10]

G. Distinct Trigonometric Function Wave Transform Fusion

Discrete trigonometric function transform has found importance for the compressed images within the variety of MPEG, JVT etc. By taking distinct trigonometric function transform, the spatial domain image is converted into the frequency domain image. Chu-Hui Lee and Zheng-Wei Zhou dynasty have divided the images into three parts as low frequency, medium frequency and high frequency. Average illumination is diagrammatic by the DC value and thus the AC values are the coefficients of high frequency. The RGB image is split into the blocks of with the dimensions of 8×8 pixels. The image is then sorted by the matrices of red, inexperienced and blue and remodelled to the greyscale image.

The two Dimensional distinct trigonometric function second transform is then applied on the greyscale image. The frequency of the greyscale block is regenerate from the spatial domain to frequency domain. Once the DCT coefficients are calculated, fused DCT coefficients are obtained by applying the fusion rule. By taking inverse DCT, the fused image is obtained. DCT based ways within which are further reliable in terms of your time and thence they are useful in real time systems. DCT coefficients show energy compactness as a results of all DCT coefficients are brought on within the low frequency zone. It provides real results once the run time information is given as an input [9].

III. PROPOSED METHODOLOGY

The main concept developed here is to use image fusion to combine the useful properties and suppress the disadvantages of the various local and global contrast enhancement techniques. The fusion-based contrast enhancement scheme is summarized in Figure below. Image fusion usually involves selecting the most informative areas from the source images and blending these local areas to induce the fused output images.

We have use MATLAB R2012b (8.0.0.783) software for simulation of projected methodology. To perform our new approach we have to require "Man" and "Aerial" images size 256x256 as a reference images for testing purpose. The testing images are artificially corrupted by Salt and Pepper impulse noise by using MATLAB and images are corrupted by different gray scale level. Basic configuration of our system is Manufacturer: Hewlett-Packard HP 4540s Processor : Intel(R) Core(TM) i3-3110M CPU @ 2.40 GHz 2.40 GHz with 4.00 GB (2.64 GB usable) RAM : System type: 32-bit OS. De-noising performances are quantitatively calculated by the PSNR and MSE as represented in analysis section respectively.

A. Different steps

The design of a general framework for combination of different fusion approaches and develops new approaches that combine aspects of pixel level image fusion. Although the fusion can be performed with more than two input images, this study considers only two input images. The proposed method can be summarized in the following steps.

Step-1: First step is to consider two input images.

Step-2: The algorithm decomposes the input image using Laplacian pyramid algorithm

Step-3: After that decomposes Gaussian pyramid algorithm.

Step-4: The new sets of detailed and approximate coefficients from each image are then added to get the new fused coefficients.

Step-5: The final step performs Laplacian pyramid reconstruction to construct the fused image.

B. Proposed Flow Chart

Here we describe the step by step procedure of the proposed image fusion technique. At first, the image to be segmented is taken as input in JPG format. The image is read by MATLAB with the help of 'imread' command and returns the image data in the array RGB (M×N×3). Next, the image is converted from RGB to grayscale image with the help of 'rgb2gray' command. The fusion of various gray scale images is maintained by local contrast enhancement method. There are three techniques of image enhancement used in this thesis. These techniques are used for performing of fusion method. After that grayscale, contrast limited adaptive histogram equalization method is obtained with the help of the function 'adapthisteq'.

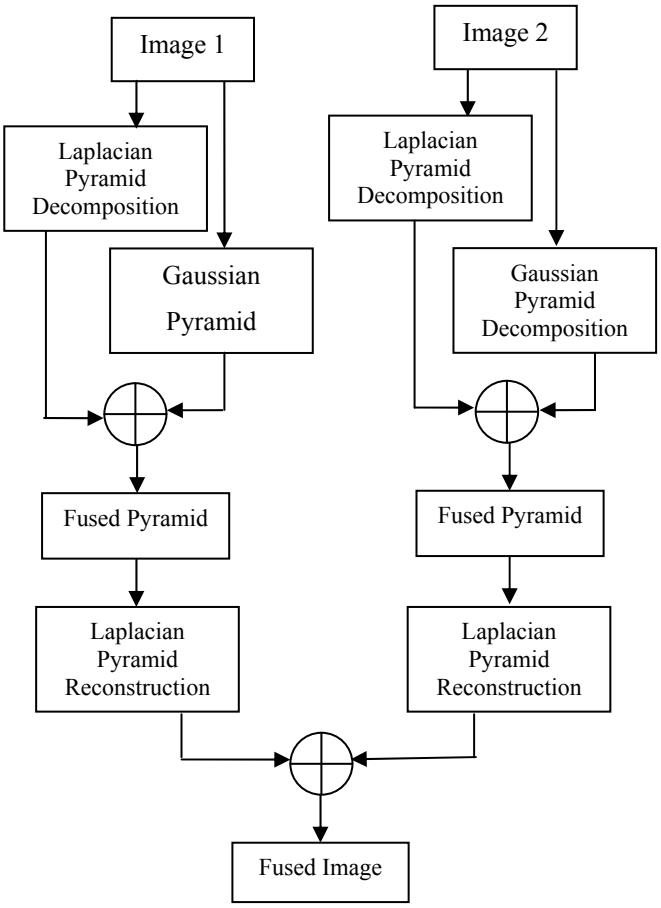

Fig. 2 Proposed Algorithm Flow Chart

IV. RESULTS

The result of proposed method is based on the entropy, AMBE & MSE

The entropy is –

$$H = -\sum_i \sum_j p_{i,j} \log_2 p_{i,j}$$

The MSE is–

$$MSE = \frac{\sum_{i=1}^{m} \sum_{j=1}^{255} \{Y(i,j) - \hat{Y}(i,j)\}^2}{m \times n}$$

Where MSE acronym of Mean Square Error stands for image enhancement factor, $m \times n$ is the size of image, Y shows the original image, $\hat{Y}$ shows the de-noised image.

The CLAHE, HE, ADJUST and Fused operators are applied to the images. Entropy has been used to measure the content of an image, with higher values indicating images which are richer in details below in table.

Table 1. Entropy of the gray level values of an image

Image	Entropy(fig no. 3)	Entropy(fig no. 4)
Gray Image	6.4843	7.8081
HE Image	5.6354	5.9846
CLAHE Image	7.3321	7.8536
Adjust Image	6.4007	7.7472
Proposed Image	10.7614	10.9760

Table 2. AMBE & MSE of the gray level values of an image

Image	AMBE (fig no.3)	AMBE (fig no.4)	MSE (fig no.3)	MSE (fig no.4)
Gray Image	∞	∞	∞	∞
HE Image	0.1508	0.1327	18.0754	12.9322
CLAHE Image	0.1311	0.0410	17.6458	20.9193
Adjust Image	0.0827	0.0492	∞	∞
Proposed Image	0.1117	0.1912	6.4646	1.9653

Here the experimentation of the proposed technique over a number of sample images and some of the results are displayed in fig. 3 and 4. We can see that the fused as obtained by MATLAB technique are different to other ways. Fig. 3 and 4 shows the results on monochrome images Man and Aerial, respectively.

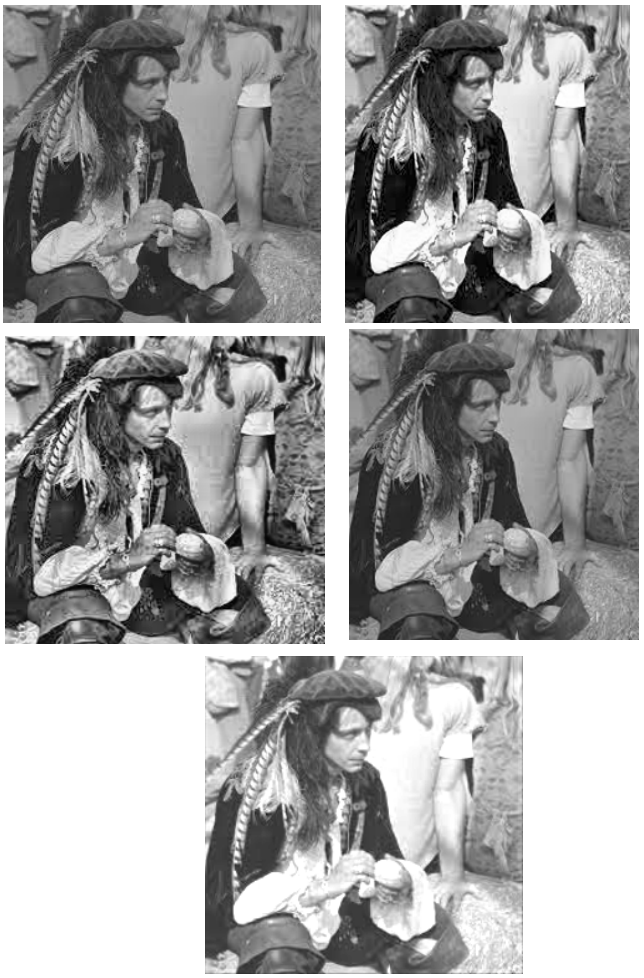

Fig. 3 Man Image (a) Input Image (b) Histogram (c) Contrast Enhancement (d) Contrast Adjustment (e) Final Output

Fig. 4 Aerial Image (a) Input Image (b) Histogram (c) Contrast Enhancement (d) Contrast Adjustment (e) Final Output

V. CONCLUSIONS

This paper presents a new method fusion based contrast enhancement for grayscale images. Here, we have proposed a new fused based enhancement methods using in MATLAB programming. It has good noise removal capability as the technique using image fusion. This methodology is well suited for application in medical imaging. The results are promising and image fusion methods or techniques open a new perspective for enhancement applications. Image fusion method is test and compares the result with different image with contrast metrics.

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