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A Survey on Various Enhancement Techniques for Satellite Image

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Abstract-
Satellite images are being used in many fields of research. Satellite images are used in many applications such as geosciences studies, astronomy, and geographical information systems. One of the major issues of these types of images is their resolution. So image resolution is an important issue in satellite imaging. Because of the low frequency nature of these images, they appears as a blurred image. Thus the resolution of these satellite images is very low. In this paper we discuss the different types of transform techniques used for image enhancement. The edges of an image can be improved by using an effective transform technique and the resolution can be improved by using interpolation technique. The combination of transform techniques and interpolation methods helps to produce an overall enhanced image.There are various wavelet domain based methods such as AHE, Discrete Wavelet Transform, CLAHE,Contrast and Stationary Wavelet Transform. Two parameters, Mean Squared Error (MSE) and Peak Signal to Noise Ratio (PSNR) are used for performance evaluation. The techniques are tested using 20 LandSat satellite images with different illumination effects. The experimentation was carried out using soft computing tool Matlab.

Keywords- Image Enhancement, DWT, AHE,CLAHE, Mean Squared Error (MSE); Peak Signal to Noise ratio (PSNR); Landsat Image.

I.INTRODUCTION

In this paper we discuss the different types of transform techniques used for image enhancement. The edges of an image can be improved by using an effective transform technique and the resolution can be improved by using interpolation technique. The combination of transform techniques and interpolation methods helps to produce an overall enhanced image. There are many approaches that can be used to enhance the resolution of a satellite image.

Wavelet domain based methods have proved themselves as most efficient technique serving for the required purpose. Interpolation in image processing is a well-known method to increase the resolution of a digital image. Many interpolation techniques have been developed to increase the

image resolution. In case of remotely sensed images, images are captured without physical contact with ground surface. A number of different sensors are used to capture the images over various regions. Such images include satellite and aerial images and these images prove useful in the fields such as determining land use patterns, environmental analysis, weather forecasting, vegetation monitoring and other related areas. Image enhancement is often required for satellite images in order to identify the

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objects and extract features and their coordinates from images.
. But the contrast of that image is not up to the mark for the so much of applications. So, improving the contrast of an image is necessary to analyze those images. Images such as LANDSAT and Quick Bird are widely acquired and processed nowadays and some types of images are processed by optimization and Adaptive Thresholding, else it can be processed by Contrast Limited Adaptive Histogram Equalization (CLAHE). These two different approaches obtain two different parameters and those parameters are in under process of IDWT.

This image enhancement has many methods, ranging from filtering methods, histogram methods, methods with multiple algorithms to even the incorporation of several methods to produce excellent image repairs. To use the image enhancement, we must understand what is contained in the image or the problem in terms of what underlies us to use the image repair method, whether from detail, color, lighting, and others. Because in image enhancement, not all methods will produce a good image after being processed. Sometimes we initially want to improve the image but instead aggravate the image. With this, we must estimate what image improvement method is needed.

In case of remotely sensed images, images are captured without physical contact with ground surface. A number of different sensors are used to capture the images over various regions. Such images include satellite and aerial images and these images prove useful in the fields such as determining land use patterns, environmental analysis, weather forecasting, vegetation monitoring and other related areas. Image enhancement is often required for satellite images in order to identify the objects and extract features and their coordinates from images. A number of methods are available for image enhancement such as contrast stretching, histogram equalization, decorrelation stretch, contrast-limited adaptive histogram equalization, convolution, linear and non-linear filters. Keeping in view the complexities of satellite images, the selection of suitable technique for image processing may differ from one application to another. There is very less work performed using these techniques for satellite and aerial images but choosing a suitable enhancement technique is a difficult task.

II Literature review:

Satellite images play a vital role in modern computer-aided applications like geographical information systems. Highresolution satellite images are mostly acquired with Synthetic Aperture Radar (SAR) imaging and are widely used in various research disciplines of remote sensing, ecology, oceanography, geology, and interferometery. But the efficient use of these satellite images is possible only if the captured images are of high quality with high-resolution pixels and free from external factors like noise, default of capturing devices, discrete sources of radiation etc [1]. While discussing the subparts of the main composed work which is such as, resolution and contrast of an image these two factors are always important issues in many image processing applications, such as satellite image resolution enhancement, feature extraction, video resolution enhancement. Due to interpolation of an image, the number of pixels in digital image increases and its applications are widely used in many

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image processing applications, such as image resolution enhancement, multiple description coding, and facial reconstruction. Many techniques have been developed to increases the resolution image enhancement by interpolation [2].

Lisani et al. presented a review on commonly used algorithms for contrast enhancement and tone mapping and tested using specific cases of satellite images such as shadowed and bright image regions. Both color images as well as grayscale images were used for enhancement of image brightness [3]. Shaikh et al. developed a simulation model in Matlab to study the effect of filtering techniques. They used linear and non-linear filtering techniques for image enhancement. The authors used non-linear filter for noise removal and histogram equalization for image enhancement. It was proved that median filter perform better than other filtering techniques and it works well for noise removal as well as to remove blurred effect in an image [4].

III Various Enhancement Techniques

A. Contrast Limited Adaptive Histogram Equalization (CLAHE)

A variation of versatile histogram adjustment called differentiates constrained versatile histogram leveling (CLAHE) keeps this by restricting the intensification. Complexity Limited AHE (CLAHE) varies from conventional versatile histogram adjustment in its differentiation restricting. This element can likewise be connected to worldwide histogram leveling, offering to ascend to differentiate constrained histogram evening out (CLHE), which is once in a while utilized as a part of training. On account of CLAHE, the complexity constraining methodology must be connected for every area from which a changing work is determined. CLAHE was developed to keep the over intensification of commotion that versatile histogram adjustment can offer ascent to.

CLAHE is a technique that operates on small blocks of the image instead of operating on the entire image. Each block is processed separately for contrast enhancement. CLAHE was basically used for enhancing low-contrast images in the field of medical imaging but it also serves as an effective enhancement method for low contrast satellite images. It works by matching the histogram of the output image with the one specified by the distribution type which can be set to flat, bell-shaped or curved histogram. This technique works well for grayscale and color images but there is high variation in the colors of original and enhanced images.

is processed by DWT to convert the image attributes to the most appropriate form used to process the same attributes. The image parameters obtained from DWT are equalized using Contrast Limited Adaptive Histogram Equalization (CLAHE) and perform IDWT to get enhanced image. Also the same image parameters are optimized to perform Adaptive Thresholding. The result of the adaptive thresholding is further processed by IDWT. The outputs of IDWT are compared by its weighted average to get the enhanced image.

B.DWT

The discrete wavelet transform has more advantages than Fourier transform during

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the applications based on the image resolution and contrast improvement [6]. The image is sampled and the image wavelets are passed through the low pass filer and perform convolution with its impulse response. The DWT of an image is given by

$$T(n) = \sum_{K=-\infty}^{\infty} S(K)U(n-K)$$

Where

T (n) is a DWT of an image

S (K) is a Wavelet Image Samples

U (N-K) is an impulse response

This approach is based on interpolation of the high frequency sub-bands which are obtained by performing Discrete Wavelet Transform (DWT) on input image. DWT decomposes the input satellite image into different frequency sub-band images namely, low-low (LL), low-high (LH), high-low (HL) and high-high (HH). Interpolation can be applied to these four sub-band images. In the wavelet domain, the low-resolution image is obtained by low-pass filtering of the high-resolution image. The low-resolution image (LL sub-band) is used as input for the proposed resolution enhancement process. The LL sub-band is used for singular value decomposition (SVD) for brightness enhancement purpose. The high frequency sub-bands contain the high frequency components of image .Interpolation is carried out using bicubic interpolation algorithm and Inverse Discrete Wavelet Transform.

C.Adaptive histogram equalization (AHE)

In adaptive thresholding, the gray scale of an image is differentiated by the reference values to convert the image attributes into the binary attributes [7]. The reference value may vary by each and every mask based on its adjacent coordinates [8], So that it is called adaptive thresholding.

Adaptive histogram equalization (AHE) is a PC picture handling strategy used to enhance differentiate in pictures. It varies from common histogram evening out in the regard that the versatile strategy registers a few histograms, each comparing to an unmistakable segment of the picture, and uses them to redistribute the daintiness estimations of the picture. It is along these lines reasonable for enhancing the neighborhood differentiate and improving the meanings of edges in every locale of a picture. In any case, AHE tends to over open up commotion in moderately homogeneous areas of a picture. A variation of versatile histogram adjustment called differentiates constrained versatile histogram leveling (CLAHE) keeps this by restricting the intensification. [5] proposed a system, this system has concentrated on finding a fast and interactive segmentation method for liver and tumor segmentation. In the pre-processing stage, Mean shift filter is applied to CT image process and statistical thresholding method is applied for reducing processing area with improving detections rate. In the Second stage, the liver region has been segmented using the algorithm of the proposed method. Next, the tumor region has been segmented using Geodesic Graph cut method. Results show that the proposed method is less prone to shortcutting than typical graph cut methods while being less sensitive to seed placement and better at edge localization than geodesic methods.

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This leads to increased segmentation accuracy and reduced effort on the part of the user. Finally Segmented Liver and Tumor Regions were shown from the abdominal Computed Tomographic image.

D.Stationary Wavelet Transform (SWT):

The stationary wavelet transform is a wavelet transform algorithm designed to overcome the lack of translational invariance of discrete wavelet transform. It is similar to DWT but it does not use down sampling hence the subbands will have the same size as input image. Down sampling in each of the sub-bands of DWT cause information loss that's the reason why SWT is employed. Image produced at the output will be of sharper high resolution image.

E.Contrast Enhancement

The conventional approach to enhance the image contrast is to manipulate the gray-level of individual pixels to the required value by constructing and transforming an intensity histogram. However, the maximization of the information content carried in the image should be taken into account when constructing the histogram. In the following, benchmark images will be used as examples to illustrate the effects of employing different strategies for histogram transformation and a definition of entropy as a measure of information will also be given. Then, a continuous distribution transformation is proposed for maximizing the information content.

IV. RESULTS AND DISCUSSIONS

Performance analysis of various resolution enhancement algorithms in wavelet domain is done and measured in terms of matrics such as PSNR and MSE as tabulated below.

Technique	PSNR	MSE
CLAHE	63.1856	0.0513
DWT	13.6043	0.0421
AHE	59.1129	0.0414
SWT	13.3209	0.0459
CONTRAST	12.9729	0.00414

V. CONCLUSION

A number of enhancement techniques were explored and performance analysis was carried out based on parameters MSE and PSNR using LandSat images. It is very important to select asuitable enhancement technique for satellite images. Also, the mentioned techniques are effective in improving the visual interpretability level in satellite images. Image enhancement techniques for satellite images can be applied in frequency domain also.

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