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Satellite Image De-Noising Using Huffman Codeing with Various Filters

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ABSTRACT: Image compression is the application of data compression of the digital image. Data compression is the techniques to reduce the redundancies in data representation in order to decrease data storage requirement and hence communication costs. Reducing the storage requirement is equivalent to increasing the capacity of the storage medium and communication bandwidth. Preprocessing stage helps to enhance the quality of an image by removing noise, irrelevant details and contrast enhancement. The proposed work has been accomplished in two phases namely pre-processing and compression. Pre-processing is necessary to eliminate the noises and to improve the quality of the image. In this phase, Wiener Filter is proposed to enhance the image quality. The filtered image is compressed using Huffman coding. Finally, the compressed image is measured by PSNR and MSE values. The proposed work is experimented with the satellite images which are collected from the NASA and ISRO space station though websites. The results of compression with and without preprocessing are compared and the compression with preprocessing yields better results.

KEYWORDS: Preprocessing, Image Compression, Huffman coding, Peak Signal to Noise Ratio, Mean Squared Error, Compression ratio.

I. INTRODUCTION

Digital image processing is a processing of images using mathematical operations by using any form of signal processing for which the input is an image, a series of images, or a video. Image compression is a manner of competently coding digital image, to decrease the total bits required in labeling the original image. Its purpose is to moderate the storage space required and transmission cost while maintaining acceptable image quality[2].
There are two types of compression techniques available:

- Lossless Compression
- Lossy Compression

Lessless Compression

Lossless Compression System aims at reducing the bit rate of the compressed output without any distortion of the image. The bit-stream after decompression is identical to the original bit stream. Lossless compression compresses the image by encoding all the information from the original file, so when the image is decompressed, it will be exactly identical to the original image[4].

Lossy Compression:

Lossy compression as the name implies, leads to loss of some information. The compressed image is similar to the original uncompressed image, but not just like the previous as in the process of compression some information concerning the image has been lost. They are typically suited to images. The most common example of lossy compression is JPEG. An algorithm that restores the presentation to be the same as the original image is known as lossy techniques. Reconstruction of the image is an approximation of the original image, therefore the need of measuring of the quality of the image for lossy compression technique. Lossy compression technique provides a higher compression ratio than lossless compression. [4].

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In this paper, Literature survey is discussed in section 2. Methodology is presented in section 3.Results are discussed in section 4. Finally conclusion is discussed in section 5.

II. REVIEW OF LITERATURE

A literature review is a written document that represents a logically argued case founded on a comprehensive understanding of the current state of knowledge about a topic of study.

Preprocessing of images commonly involves removing low-frequency background noise, normalizing the intensity of the individual particle images, removing or enhancing data images prior to computational processing[11].

Sundaram *et al.* [5] have developed a preprocessing of mammogram image using an adaptive median filter, which is a preprocessing technique for enhancing the content of medical image based on removal of special markings and noise. Removal of special markings and noise existing in medical images will increase the quality of image segmentation. Here three types of filtering techniques for pre-processing of mammography images are considered. The output parameters such as image quality, mean square error, peak signal to noise ratio are compressed of three types of filters are tested on mammogram images.

Deepa *et al.* [3] have developed an efficient denoising and enhancement technique for medical image, the filter which provided the efficient denoising. Present approach has implemented a contrast Enhancement and de-noising technique, and the medical image is given as the input, if the input image is color image, then it is converted into grayscale in order to reduce the processing time the contrast of the input image is enhanced and the image is denoised using various filter and the quality and accuracy is measured by PSNR and MSE value and we evaluated the best de-noised image according to these value.

Sahnoun, K., *et al.* [7] Have presented a new coding scheme for satellite image. The Fast Fourier transform and the scalar quantization for standard LENA image and image satellite image, the (SQ) phase is encoded using entropy, after decompression. In this paper, we can discuss the achieve higher compression ratios, more than 78%.

A hybrid fractal image compression method for satellite images have presented by Yashavanth, E., *et al.* [8]. It can decompose images into low frequency sub-band and high frequency sub-band. Affine transformation and iterative function system techniques have been applied to the compression, decompression the satellite images. It will show the significant improvement in the compression ratio, PSNR values and encoding time.

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III. METHODOLOGY

In this proposed work the Satellite images are compressed. The PSNR and MSE values are for evaluating image quality in both Preprocessing and compression stages. The phases in the proposed work is shown in figure 1.

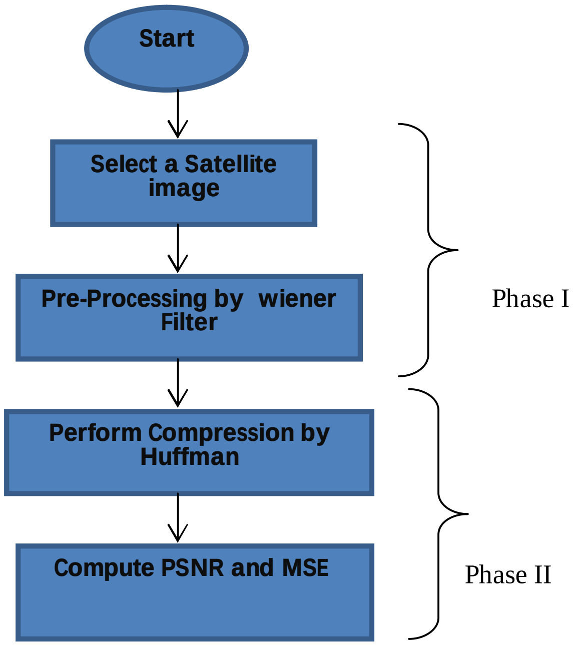

Figure 1. Diagram of Proposed Methodology

The proposed work has two phases, preprocessing is performed in first phase and compression is done at the next phase. Finally PSNR and MSE values are calculated.

Pre-processing is removing noise from the image so it is essential when processing the image, in the proposed work involving the image into pre-processing before the image will be compressed. In pre-processing, apply the filters to an image[2].

The noise is characterized by its pattern and probabilistic characteristics. There are a wide variety of noise types. Some of them are: Gaussian noise, salt and pepper noise, speckle noise.[1]

In image processing filters are mainly used to suppress either the high frequencies in the image, i.e. smoothing the image, or the low frequencies, i.e. enhancing or detecting edges in the image. The filter function is shaped so as to attenuate some frequencies and enhance and others. There are many filters available in Matlab. In proposed work, three filters are applied into image sets[5].

A) WIENER FILTER

The wiener filtering method requires the information about the spectra of the noise and the original signal and it works well only if the underlying signal is smooth. Wiener method implements spatial smoothing and its model complexity control correspond to choosing the window size [5]. Wiener filtering is able to achieve significant noise removal when the variance of noise is low; they cause blurring and smoothening of the sharp edges of the image [5].

B) MEDIAN FILTER

Median filtering is a common step in image processing. Median filter is a well used nonlinear filter that replaces the original gray level of a pixel by the median of the gray values of pixels in a specific neighborhood. The median filter is also called the order specific filter because it is based on statistics derived from ordering the elements of a set rather than taking the means. This filter is popular for reducing noise without blurring edges of the image [1]. It is particularly useful to reduce salt and pepper noise and speckle noise. It is very useful in case where edge blurring is undesirable because of its edge preserving nature[5].

$$\textbf{Median} = \hat{f}(x,y) = \underset{(s,t)\in S_{xy}}{median}\{g(s,t)\} \quad \ldots(1)$$

C) GAUSSIAN FILTER

Gaussian filters are designed to give no overshoot to a step function input while minimizing the rise and fall time. This behavior of Gaussian filter causes minimum group delay. Mathematically, a Gaussian filter modifies the input signal by convolving with a Gaussian function. The Gaussian filter is usually used as a smoother. The output of the Gaussian filter at the moment is the mean of the input values [5].

$$\textbf{Gaussian} = G_\sigma(x,y) = \frac{1}{2\pi\sigma^2}\exp - \frac{x^2 - y^2}{2\sigma^2} \quad \ldots(2)$$

Image compression is a process of efficiently coding digital image, to decrease the total bits required in describing the original image. Its purpose is to reduce the storage space required and transmission cost while maintaining acceptable image quality. Compression is useful because it helps to reduce the consumption of expensive resources, such as hard disk space or transmission bandwidth (computing). On the downside, compressed data must be decompressed, and this extra processing may be detrimental to some applications. For instance, a compression scheme for image may require expensive hardware for the image to be decompressed fast enough to be viewed as its being decompressed. The design of data compression schemes therefore involves trade-offs among various factors, including the degree of compression, the amount of distortion introduced and the computational resources required to compress and uncompress the data[6].

Huffman coding is an entropy encoding algorithm used for lossless data compression in computer science and information theory. The term refers to the use of a variable-length code table for encoding a source symbol (such as a character in a file) where the variable-length code table has been derived in a particular way based on the estimated probability of occurrence for each possible value of the source symbol[9].

Huffman coding uses a specific method for choosing the representation for each symbol, resulting in a prefix-free
code (that is, the bit string representing some particular symbol is never a prefix of the bit string representing any other symbol) that expresses the most common characters using shorter strings of bits than are used for less common source symbols[10].

Huffman was able to design the most efficient compression method of this type: no other mapping of individual source symbols to unique strings of bits will produce a smaller average output size when the actual symbol frequencies agree with those used to create the code. A method was later found to do this in linear time if input probabilities (also known as weights) are sorted[10].

The following mathematical metrics are used for the evaluation of the algorithm.

- Mean Squared Error
- Peak Signal to Noise Ratio

Mean Squared Error

Mean square error also called average prediction error. It is calculated as the average of the difference between the decompressed and original image. Higher value of MSE gives poor quality image.

$$\text{MSE} = \frac{1}{MN}\sum_{y=1}^{m}\sum_{x=1}^{n}(I(x,y)-(K(x,y)^2) \quad \ldots(4)$$

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Where I is original image, K is an approximation of decompressed image and m, n are pixels of the image. A lower value of MSE means lesser error, and it has the reverse relation with PSNR. It measures the average of the square of the error. It is the second moment of error an its lower value indicates better picture quality[7].

Peak Signal Noise Ratio

PSNR is a measure of the peak error. Many signals have very wide dynamic range, because of that reason PSNR is usually expressed in terms of the logarithmic decibel scale in (dB). MSE and PSNR are very useful parameter to compare the image quality[7].

$$PSNR(dB)= 20\log_{10}\frac{1}{\sqrt{MSE}} \qquad \ldots(3)$$

The steps in the proposed work are given below.

Input : Original Image
Output: Compressed Image

// Compression of Satellite Images //
Step 1: Start
Step 2: Select an input image from Satellite dataset.
Step 3: Preprocess the image with the following
- Apply the Median Filter.
- Apply the Wiener Filter.
- Apply the Average Filter.
- Apply the Gaussian Filter.

Step 4: Estimate MSE and PSNR values.
Step 5: Compared the MSE and PSNR values for above applied filters.

Step 6: Repeat the Step 2 to 5 for all images in the satellite database.
Step 7: Preprocessed images are applied to Huffman code for compression.
Step 8: Estimate MSE and PSNR values.

Step 9: End.

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VI. EXPERIMENTAL RESULTS

The preprocessing results are shown in figure 2-3.


Fig. 2a(Original image) **Fig. 2b(Wiener filter)**

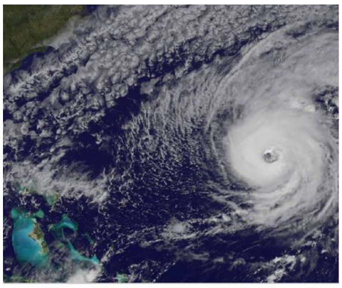


Fig. 3a(Original image) **Fig. 3b(Average filter)**

Table 1. Performance comparison of preprocessed with various filters

Filters	**Wind Satellite image**		**Urban Satellite image**	
Various Filters	**PSNR**	**MSE**	**PSNR**	**MSE**
Median	26.17	26.11	26.68	26.60
Gaussian	29.22	29.21	28.17	28.11
Average	26.17	26.11	25.11	25.10
Wiener	34.10	33.72	34.17	30.17

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With the analysis of the values in the table the Wiener Filter is better with MSE and high PSNR values. In order to evaluate the performance of the Wiener Filter obtained results are compared with the standard filter are shown in the following table 1. The result of the filtering images are shown in the figure 2(a,b)-3(a,b).

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Fig. 4. Without filter (compressed image)

Fig 4. To shows the result of without preprocessing image to be compression.

Fig. 5. With filter (compressed image)

Fig. 5. To shows the result of with preprocessing image to be compression.

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Table 2. Results of Compression

Measurements	With pre-processing image	Without pre-processing image
PSNR	44.07	29.55
MSE	38.39	30.07
Compression Ratio	49.9	35.38

With the analysis of the values in the table the result of with preprocessing is better than without preprocessing result. Because with pre-processing result gives less MSE and high PSNR values as shown in the table 2.

V. CONCLUSION

The proposed work of compression is an efficient idea that is being implemented. Here reducing the space occupancy of the stored satellite images without any reduction in its quality and its resolution of the image. Pre-processing techniques for enhancing the content of satellite image based on removal of noises. Here four types of filtering techniques for pre-processing of satellite images are considered. The mean square error, peak signal to noise ratio are measured for the four filters and compared. Wiener Filter is proposed to enhance the image quality. Wiener filter resulted with PSNR and MSE value gives the better value compare with other three filters. The filtered image is compressed using Huffman coding. Finally, the compressed image is measured by PSNR and MSE values.

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