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An Intelligent New Age Method of Image Compression and Enhancement with Denoising for Bio-Medical Application

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Abstract— Image compression is the reduction or elimination of redundancy in data representation in order to achieve reduction in storage and communication costs. In this paper, we are presenting the wavelet using SPIHT algorithm to compress the gray color images. This finds the coefficients of uncompressed image and minimize the number of bits to represent the image. The Huffman encoder is also designed in which the JPEG standardized table values are used for further compression. The compression of an image is followed by enhancement techniques to improve the contrast of an image. An enhancement algorithm is one that yields a better quality image for the purpose of some particular application which can be done by either suppressing the noise or increasing the image contrast Enhancement of image, One of the conventional methods adopted is the Histogram Equalization (HE) technique. The main limitation of this technique causes unpleasant visual artifacts, such as over enhancement, level saturation and raised noise level. Histogram Equalization with Improved Switching Median Filtering technique (WTHEISMF) which eliminates the impulse noise and preserves the edges of an image. This paper presents the parameters comparison and simulation results of HE, WTHE and WTHEISMF with Absolute Mean Brightness Error (AMBE), Measure of Enhancement (EME), Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE).

Keywords-SPIHT, DWT, Histogram Equalization, contrast enhancement, Impulse noise, Improved Switching Median Filter

I. INTRODUCTION

With the rapid developments of imaging technology, image compression and image enhancement techniques plays vital role. It is necessary to evolve the coding standards for image compression so that there is compatibility and interoperability between the image analysis and storage in the medical field. The image compression techniques utilize two steps to reduce the size of the image:

1. Removal of redundancy based on implicit assumption about the structure in the data.
2. Assignment of binary code words to the information deemed non-redundant.

Some compression algorithms are patented and may only be used under license. Others have been developed as open standards. This can be an important consideration in terms both of creation costs and long-term sustainability. The patenting of compression algorithms is a complex and controversial issue which is beyond the scope of this paper. Due to the image compression the quality and characteristics of an image will be affected.

The objective of image enhancement technique is to improve the characteristics or quality of an image, such that the resulting image is better than the original image. To improve the image contrast, numerous enhancement techniques have been proposed. One of the conventional methods adopted is the Histogram Equalization (HE) technique. The main limitation of this technique causes unpleasant visual artifacts, such as over enhancement, level saturation and raised noise level. To overcome these limitations technique like Dualistic Sub-Image Histogram Equalization (DSIHE), Brightness Preserving Bi-Histogram Equalization (BBHE) and Weighted Threshold Elementary enhancement techniques are histogram based because they are simple, fast and produces acceptable results for some applications can be achieved.

Elementary enhancement techniques are histogram based because they are simple, fast and produces acceptable results for some applications can be achieved. Histogram modification basically modifies the histogram of an input image so as to improve the visual quality of the image. Histogram equalization is a process that attempts to spread out the gray levels in an image so that they are evenly distributed across their range. In the histogram equalization without any modification, it over enhanced the output image and raised noise level. A number of methods have been proposed [3] for limiting the level of enhancement by modifying the histogram equalization.

The recent method proposed to enhance an image using HE is Adaptive HE methods and Global methods based on Histogram equalization [4]. In the above two proposed method, AHE methods can provide high level of enhancement compare to the Global methods. Bi-Histogram Equalization was proposed to reduce the mean brightness change in an image. BHE is a modified version of Histogram Equalization [3, 4]. In this method initially an

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image is partitioned into two sections based on average of the histogram and then applies histogram equalization on each section individually. A similar improved Histogram based method is Dualistic Sub-Image Histogram Equalization (DSIHE)[3,4]. In these methods, initially histogram is partitioned into two fragments based on entropy and then applies histogram equalization on both the fragment. In the above method the enhanced image is more satisfying than Histogram equalization but not possible to change the level of enhancement [3]. The aforementioned problems can be overcome by Weighted Threshold Histogram Equalization.

The general idea adopted by the WTHE [4] method is to modify the histogram before equalization is conducted. Such modifications reduce visual artifacts. During the image enhancement the impulse noise in the image also enhanced [5]. To avoid this effect, the enhanced image is passed through a filter. In digital signal and image processing; an image is often corrupted by noise in its acquisition or transmission. Noise is undesirable information that contaminates an image. So the conventional filtering techniques are used to eliminate the noise and to preserve the edges. Several filtering techniques have been reported are linear filtering; averaging filtering and nonlinear filtering [6]. The linear filtering tends to blur the edges, and do not remove the noise effectively. Nonlinear filtering is generally used for the removal of impulse noise due to some advantages like preservation of edges. The nonlinear filtering is used in various fields like image processing, Telecommunication, Geo physical signal processing.

The median filter is an effective method for the removal of impulse based noise on images [5]. It is also called as sliding window filter, which replace the center value in the window with the median of all pixel values in the window. This is due to the partial averaging effect of the median filter and its biasing of the input stream, rather than straight mathematical averaging. The drawback of using this median filter is that they cannot detect whether the pixel is noisy or not, so they replace both noisy as well as noise free pixel which makes the image to become visible blur. The aforesaid problems can be overcome by modified forms of the median filter have been proposed [5].The weighted median filtering method assign weight to each pixel values; it duplicates the pixel values for several times. The existing median filtering technique decreases the quality of the enhanced images rather than improving the quality of an image. The Improved Switching Median Filtering technique [7] is used to reduce the noise level in enhanced image and preserving the edges of an image. So this paper presents a new novel approach for image contrast enhancement using Weighted Threshold Histogram Equalization with Improved Switching Median Filter.

This paper is organized as follows. Section II gives the Histogram Equalization technique procedure. Following section III explains the details about Weighted Threshold Histogram Equalization. Section IV presents the Improved Switching Median Filtering technique and its advantage. In section V presents the detail about proposed method, Simulation results and discussions are presented in Section VI. Finally Conclusion is provided in section VII. The simulation result is tested using MAT Lab tool.

II. DISCRETE WAVELET TRANSFORM

Wavelets [7] are mathematical functions that decompose data into different frequency components, and then study each component with a resolution matched to its scale. WAVELET TRANSFORMS have several advantages over discrete cosine transform. They no need to divide the input into non-overlapping 2-D blocks, it has higher compression ratios avoid blocking artifacts. It allows good localization both in time and spatial frequency domain.

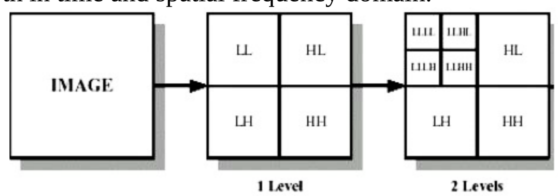

Fig.1. Frequency decomposition of image

Wavelet transform decompose the image into different sub bands. It divides the image into four sub bands as Low-Low, Low-High, High- Low and High-High vertically and horizontally as shown in the figure. Each band is further sub divided into four sub bands and this process will be repeated several times to get the wavelet coefficients. The original image can be reconstructed again from coefficients by applying the IDWT (Inverse Discrete Wavelet Transform).

III. SPIHT ALGORITHM

Set Partitioning in Hierarchical Trees (SPIHT) is a powerful wavelet-based image compression method. This algorithm partitioning the wavelet coefficients into significant pixels and insignificant pixels based on the following function

$$S_n(T) = \begin{cases} 1, \max_{(i,j)\in T} \{ |c_{i,j}| \} \geq 2^n \\ 0, \text{Otherwise} \end{cases} \text{------} \quad (1)$$

Where Sn(T), is the significance of a set of co-ordinates T, and ci,j is the coefficient value at co-ordinate (i,j) . There are two passes in the algorithm - the sorting pass and the refinement pass. The sorting pass is performed on the list of insignificant sets (LIS), list of insignificant pixels (LIP) and the list of significant pixels (LSP). The LIP and LSP consist of nodes that contain single pixels, while the LIS contains nodes that have descendants. During the sorting pass, those co-ordinates of the pixels which remain in the LIP are tested for significance by using eqn. 1. The result, S,,(T), is sent to the output. Those that are significant will be transferred to the LSP as well as having their sign bit output. Sets in the

LIS (which consists of nodes with descendants will also have their significance tested and, if found to be significant, will be removed and partitioned into subsets. Subsets with a single coefficient and found to be significant will be added to the LSP, or else they will be added to the LIP. During the refinement pass, the nth most significant bit of the coefficients in the LSP is output. The value of n is decreased by 1 and the sorting and refinement passes are repeated. This continues until either the desired rate is reached or n =0, and all the nodes in the LSP have all their bits output. The latter case will result in almost perfect reconstruction as all the coefficients are processed completely. The bit rate can be controlled precisely in the SPIHT [1] algorithm because the output produced is in single bits and the algorithm can be terminated at any time. The decoding process follows the encoding exactly and is almost symmetrical in terms of processing time.

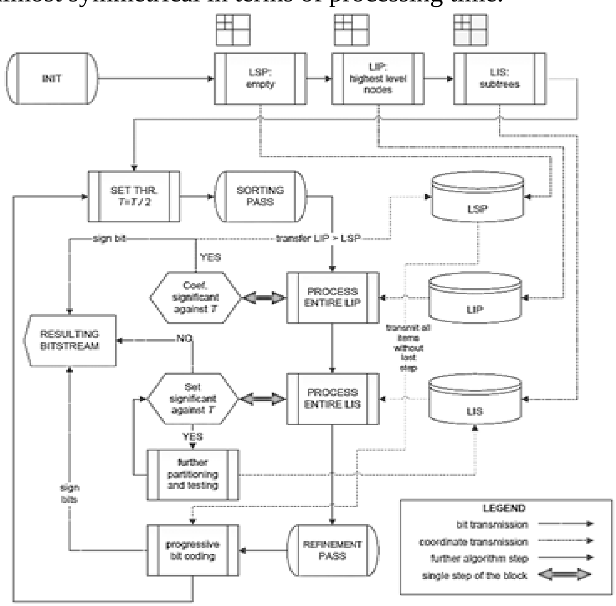

Fig. 2 Flow chart for SPIHT Algorithm

The flow chart of SPIHT algorithm shown in fig.2.
SPIHT makes use of three lists – the List of Significant Pixels (LSP), List of Insignificant Pixels (LIP) and List of Insignificant Sets (LIS). These are coefficient location lists that contain their coordinates. After the initialization, the algorithm takes two stages for each level of threshold – the sorting pass (in which lists are organized) and the refinement pass (which does the actual progressive coding transmission). The result is in the form of a bit stream.

IV. WEIGHTED THRESHOLD HISTOGRAM EQUALISATION WITH IMPROVED SWITCHING MEDIAN FILTER

This method has several advantages over conventional methods like Histogram equalization and weighted threshold histogram equalization. Histogram Equalization over enhances the background of the image and often produces the improbable effects in the image. Weighted Threshold Histogram Equalization overcomes this disadvantage but it also enhances the impulse noise in the image during enhancement.

To avoid this effect, the enhanced image is passed through a filter. One of the commonly used filters is median filter. The drawback of using this median filter is that they cannot detect whether the pixel is noisy or not, so they replace both noisy as well as noise free pixel which makes the image to become visible blur. The aforesaid problems can be overcome by modified forms of the median filter have been proposed [5].The weighted median filtering method assign weight to each pixel values; it duplicates the pixel values for several times. The existing median filtering technique decreases the quality of the enhanced images rather than improving the quality of an image. The Improved Switching Median Filtering technique [7] is used to reduce the noise level in enhanced image and preserving the edges of an image. So in this paper to improve the quality of the compressed image contrast enhancement is done using Weighted Threshold Histogram Equalization with Improved Switching Median Filter.

V PROPOSED METHOD

The proposed method offers image compression followed by Weighted Threshold Histogram Equalization with Improved Switching Median Filtering technique (WTHEISMF).As mentioned in section I, there are some problems in image compression using SPIHT algorithm. We overcome these problems in our proposed method by the Weighted Threshold Histogram Equalization with Improved Switching Median Filtering technique (WTHEISMF).
The proposed method consists of three stages.

1. Compress the image using SPIHT algorithm.
2. Enhance the image using Weighted Threshold Histogram Equalization
3. Enhanced image is passed through an ISMF

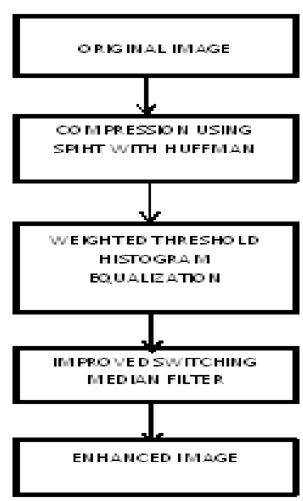

Fig.3 Flowchart for proposed method.

The flow chart of proposed method is represented in fig.3.In this method using the weighted threshold histogram equalization techniques the image is enhanced, preserves the over enhancement and level clipping. While the enhanced image is passed through an improved switching median filter, it reduces the impulse noise created during the enhancement.

VI SIMULATION RESULTS AND DISCUSSION

In order to test the proposed method, experiments are performed on skull image size 256 $\times$256.To evaluate the image enhancement and restoration performance, Absolute Mean Brightness Error(AMBE), Measure Of Enhancement(EME), Peak Signal To Noise Ratio(PSNR), Mean Squared Error(MSE) used as the criterion.

The AMBE is defined as total difference between input and output mean values [15].

$$AMBE_n = \left| E(X) - E_n(Y) \right| \qquad (2)$$

The measure of enhancement (EME), it gives an average contrast of an image by partition an image into non overlapping segments. The measurement is based on maximum and minimum intensity of each segment and averaging them. The MSE value is given by

$$MSE = \frac{1}{ij}\sum_{m=0}^{i-1}\sum_{n=0}^{j-1}(x(m,n) - y(i,j))^2 \qquad (3)$$

Where the size of an image is $i \times j$ .The original and restored images are $x(m,n)$ and $y(i,j)$ .The PSNR is the ratio between the maximum possible power of a signal and the power of corrupted noise.

$$\text{PSNR} = 20 \times \log_{10}(255/\text{sqrt (MSE)}). \quad (4)$$

The performance of the compressed images is compared with the conventional histogram equalization technique followed by improved switching median filter and the result of weighted threshold histogram equalization followed ISMF is compared with the compressed image. Only a few of the results are shown in this paper.

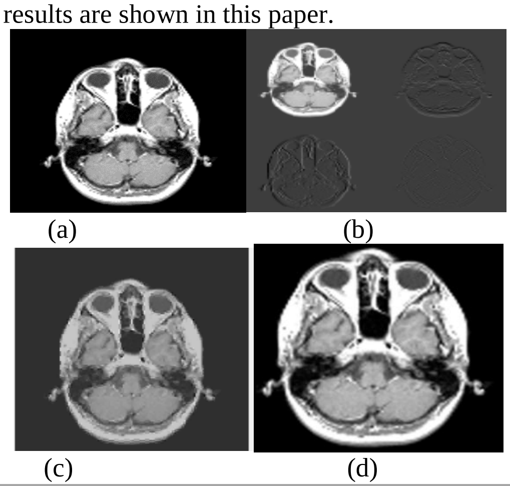

Fig. 2 Results forskull image (a) Original Image (b) DWT of image (c) Compressed image(d) WTHE followed by ISMF

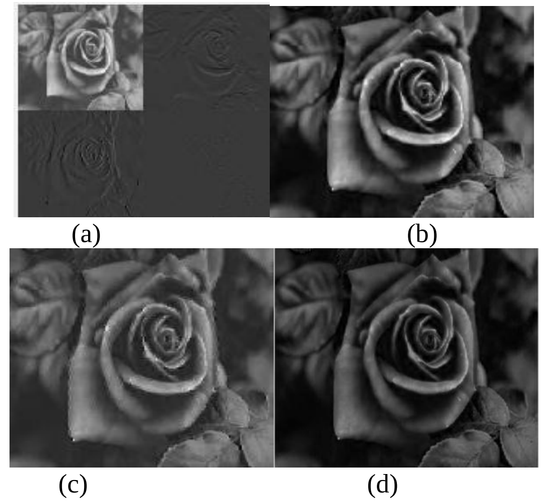

Fig.2 Results for Rose image (a) Original Image (b) DWT of image (c) Compressed image (d) WTHE followed by ISMF

TABLE 1 QUANTITATIVE MEASUREMENT RESULTS

Image	Compression Ratio	PSNR	Mean square error
Skull	2.178	36.156	15.75
Rose	1.527	39.200	7.818

Image	AMBE		EME	
	HE	WTHE	HE	WTHE
Skull	615.6694	11.062	6.4481	3.752
Rose	114.53	40.16	12.04	5.882

TABLE 2.MSE and PSNR for proposed and existing method

IMAGE	MSE	PSNR
	WTHE followed by ISMF	WTHE followed by ISMF
	3.25	42.80
SKULL	2.9057	43.49

TABLE 3. MSE and PSNR for proposed method

The proposed algorithm is compared with histogram equalization. In the Histogram equalization, the pixels are spreading uniformly. Usually Histogram Equalized resultant images are unnatural look that means it over enhances the images. The WTHE reduces the effect caused by the histogram equalization. When the contrast of an image is enhanced, as an upshot the noise induced in the image will be high and the image looks unnatural. In this paper, the proposed technique can be effectively used to improve the contrast of images and filter out the noises in the image and preserves the edges. Computed quantitative measures AMBE and EME value for histogram equalization and weighted threshold histogram equalization are listed in table I. Comparison of AMBE and EME values show that the proposed methods outperform well compared to the histogram equalization. For the proposed method, the computed value of PSNR and MSE value for WTHE followed by Median and ISMF are listed in Table III. From the table, we conclude that the PSNR and MSE values are better than the compressed image.

VII CONCLUSION

A novel approach to image compression followed by WTHEISMF is proposed which is better than the existing image compression and histogram equalization method. The proposed method depicts that the image enhancement and restoration parameters like AMBE, EME, PSNR and MSE are outperform well as compared to the existing method. It effectively reduces over-enhancement, level clamping artifacts and impulse noise produced due to enhancement. The proposed method is computationally easy and can be implemented on FPGA and work well on real time processing system.

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