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WAVELET BASED NEW COMPRESSION TECHNIQUE WITH ENHANCED QUALITY MEDICAL IMAGES

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ABSTRACT:- The aim of this research is to examine and evaluate a suitable image quality metrics as applied to medical image compression based on wavelet transform and figure out why a voluminous range of quality metrics are used ranging from simple objective mathematical assessment to complex subjective analysis. Wavelet based image compression is a cutting edge technology in the field of image processing. One of the main problems and challenges in the image compression schemes is the lack of a well defined and accepted metric for the prediction of image quality of the compressed images. The most commonly, regularly and frequently used image quality metrics for image compression system are remain simple and mathematically tractable such as peak signal to noise ratio (PSNR) or mean squared error (MSE). These simple objective based metrics do not accurately predict the visual quality of medical images which contain a large luminance variations such as edges and textured regions of complex systems of the human body. This study not only highlights how image quality metrics can be used to guide an image compression scheme in general but it also outlines the pros and cons of a number of quality metrics in particular and their limitations to medical images.

KEYWORDS: Wavelet filter; compression techniques; medical images

1. INTRODUCTION

An efficient and optimal image coder not only depends on compression algorithm but also counts on the statistics of the input image [1]. Much of the research work was mainly focused on the objective analysis of the compressed image based on the peak signal to noise ratio (PSNR), Mean square error (MSE), compression ratio (CR) and bit per pixel (BPP) of the coder [2]-[3]. Peak signal-to-noise ratio (PSNR) has been used for the purpose of comparison because it is easy to calculate and is mathematically tractable[4]. Motivation of this study is to investigate the correlation between the image characteristics and coding performance based on certain image statistics like entropy, energy, edges, image gradient, skewness and kurtosis [5]

2. RELATED WORKS

SMART e-Health Gateway or E-health administrations have been endeavouring to utilize the multimedia computing and multimedia communication such as teleradiology, teleconsultation, telemedicine, telediagnosis and telematics for better patient care and timely services [6]. With the expanding utilization of multimedia technologies and utility computing such as cloud computing, grid computing and cluster computing on the medical domain make the e-Health offerings extremely effective, reasonable and inevitable benefits even to the common men [7]. Biomedical imaging system has become one of the most imperative representation, visualization and interpretation methods and procedures in the field of medicine not only for diagnostic of diseases and abnormalities but it also plays a major role in modern e-health services [8]. The medical communication system is an innovative and cutting-edge technology that allows any type of medical information and therapeutic data to be transmitted within the framework from point of care to the desired specialist(s). The information is transmitted safely, Tomography (SPECT), Positron Emission Tomography (PET), Nuclear Medicine (Scintigraphy), Computed Tomography (CT) pictures, Digital Subtraction Angiography (DSA), Digital Flurography (DF) and X-ray imaging (Radiography) [10]. Wearable Internet of Things (IoT) devices, Ubiquitous Sensor Networks (USN) and Body Sensor Networks (BSN) furthermore create an immense collection of bio signals, for instance, heart-rate, oxygen level, breath and blood pressure at low cost [11].

Storing and transmitting such a large volume of medical image data and bio-signals for e-health services on utility computing like cloud platform across the globe for telediagnosis is very critical, tedious andtime consuming job [12]. For the past two decades, capable and effective compression algorithms have been proposed and utilized in order to diminish transmission time and storage costs. It is most likely that image compression is one of the successful, inevitable and predominant research areas in the field of image processing and that transform based image compression is very efficient and practically adopted in JPEG and JPEG-2000 coder [13]. A well-knowntransform based data compression techniques are Discrete Cosine Transform (DCT) [14, Karhunen-Loeve Transform (KLT) [15], Discrete Fourier Transform (DFT) [16], Discrete Sine Transform (DST) [17], Walsh Hadamard Transform (WHT) [18], Burrow-Wheeler (BWT) [18] and Discrete Wavelet Transform (DWT) [18]. The wavelet transform has emerged as cutting-edge technology not only in the field of image processing but also in the domain of image compression. Recently variety of medical image compression methods using wavelet transforms have been proposed by many researchers [19].

In this study, we evaluate the performance of state-of-the-art quality metrics with respect to compressed medical images from different modalities. We investigate not only the performance of the emerging image compression standard but also high effectiveness coding for medical image compression. The simulation results show that diagnostically reliable compressed image can be obtained through the advanced and propelled wavelet-based algorithms [23].

3. PROPOSED APPROACH

Proposed Algorithm for Coding Performance of Image Statistics

Algorithm steps of the implementation of wavelet-based compression technique are given below:

1. Load Image in MATLAB using Image Acquisition
2. Pre-processing of colour images
3. Study pre-processing effects of the given image (first order and second order statistics)
4. Apply Discrete Wavelet Transform (2D-DWT) based on HAAR mother wavelet.
5. Wavelet decomposition

6.. Perform vector quantization
7. Apply codebook algorithm
8. Apply variable entropy coding Huffman or Arithmetic coding
9. Perform wavelet reconstruction
10. Study histogram probability reduction function on RGB components using Mean intensities (energy, entropy, and image gradients).
11. Study quality assessment of the compressed image based on CR, MSE and PSNR
12. Repeat the above all steps for rest of the images.

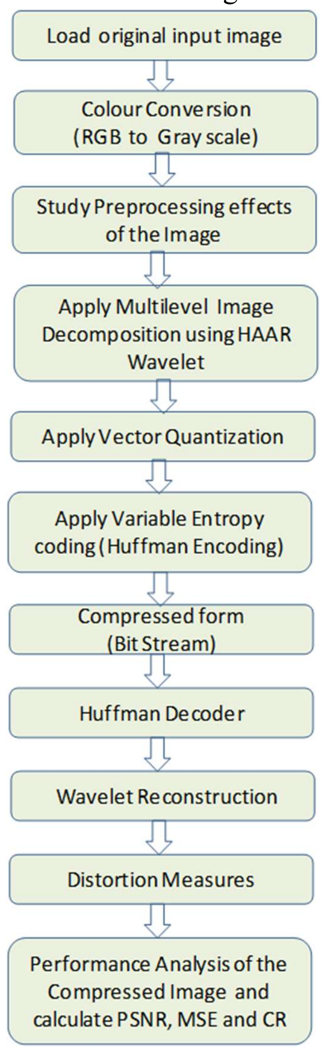

Fig. 1: Flow diagram for implementation of the proposed Compression Algorithm

4. DATASET AND EXPERIMENTS

The medical images which were used for investigation of this research work are downloaded from the online free medical data bases for the public utility services. Experiments were done on many medical images of different modalities. These test images are grouped into three categories based on its storage format such as JPEG , PNG and GIF form. These include X ray lung, X ray hand, retinal images, MRI brain, liver ultra sound, CT spine, skull, and video clipping in order to assess the performance of the proposed algorithm.

Fig2 Test Medical Images of JPEG Format

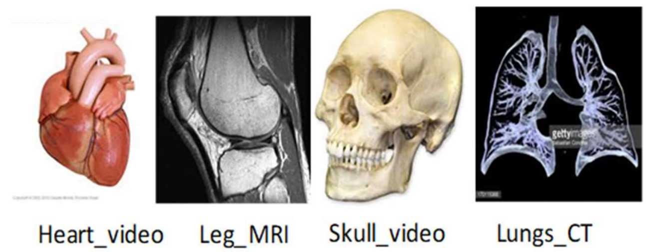

Fig 3 Test Medical Images of PNG Format

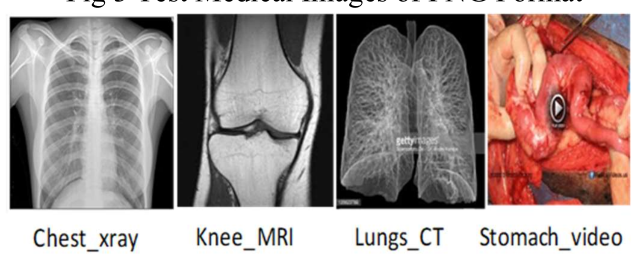

Fig 4 Test Medical Images of GIF Format

5. EXPERIMENTAL ANALYSIS

In this experiment, we have done compression and reconstruction of a selected set of medical images from different modalities by using the Daubechies (db2) wavelet filter at four different decomposition levels which are level 1, level 2, level 3, and level 5 [68]. All these images are grey scale image with depth 8 bits per pixel. The following figures show comparison of reconstructed X-ray image (256 x256 pixels, 8 bit pixel) for 1,2,3,5 levels of decompositions at bit rate 1 bpp.

Wavelet Filter : **Daubechies (db2),**

Image Name : MRI Head,

Format: jpeg/jpg Image size : 214 x 234

Table 1 Performance Results of Compression Scheme based on DWT Decomposition Level: 1

Threshold	Mean Square Error (MSE)	PSNR in db	Compression Ratio (CR)
0.5	0.00908	68.5514	24.14
2	0.1675	55.8902	35.261
5	1.568	46.1761	46.592
10	8.533	38.8196	58.846
15	21.72	34.7622	67.137

20	40.37	32.0707	73.066

Table 2 Performance Results of Compression Scheme based on DWT Decomposition Level: 2

Threshold	Mean Square Error (MSE)	PSNR in db	Compression Ratio (CR)
0.5	0.00906	68.5605	24.215
2	0.1668	55.9082	35.282
5	1.559	46.2018	46.55
10	8.496	38.8385	58.769
15	21.63	34.781	67.039
20	40.17	32.0917	72.946

Table 3 Performance Results of Compression Scheme based on DWT Decomposition Level: 3

Threshold	Mean Square Error (MSE)	PSNR in db	Compression Ratio (CR)
0.5	0.00716	69.581	21.099
2	0.123	57.2307	29.181
5	1.253	47.151	38.208
10	7.065	39.6399	48.511
15	17.83	35.6188	55.367
20	32.25	33.0459	60.033

Table 4 Performance Results of Compression Scheme based on DWT Decomposition Level: 5

Threshold	Mean Square Error (MSE)	PSNR in db	Compression Ratio (CR)
0.5	0.00908	68.5514	24.14
2	0.1675	55.8902	35.261
5	1.568	46.1761	46.592
10	8.533	38.8196	58.846
15	21.72	34.7622	67.137
20	40.37	32.0707	73.066

We conclude from our experimental result that the optimal number of decompositions depends on filter order (number of decompositions). It shows the performance of PSNR values for different filter orders. As the number of decompositions increases, PSNR is increased up to some number of decompositions. Beyond that, increasing the number of decompositions has a negative effect. Higher filter order does not imply better image quality because of the filter length, which becomes the limiting factor for decomposition. Decisions about the filter order and number of decompositions are a matter of compromise. A suitable number of decompositions should be determined by means of image quality and less computational operation.

It depicts the performance of Compression Ratio (CR) with respect to Threshold ofDaubechies (db2) wavelet filter based on the various levels of decompositions (Level1, 2, 3 and 5). From the Graph the simulation result clearly shows that there is no significance changes of the performance of the compression ratio after the decomposition level 3 onwards

VI CONCLUSION

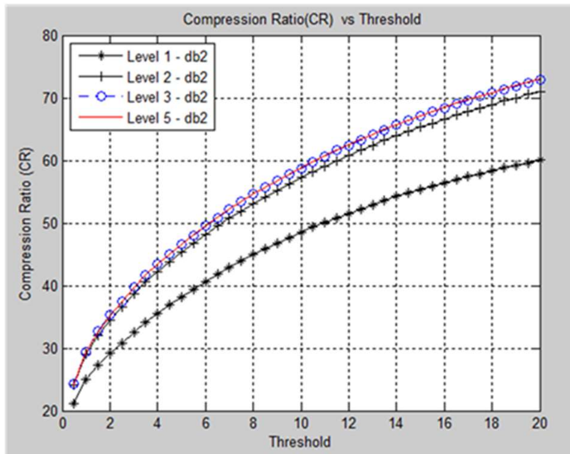

Fig 5 Performance of Compression Ratio (CR) with respect to Threshold of Daubechies (db2) wavelet filter based on the various levels of decompositions (Level 1, 2, 3 and 5)

figure illustrates the performance of Mean Square Error (MSE) with respect to Compression Ratio (CR) of Daubechies (db2) wavelet filter based on the various levels of decompositions (Level 1, 2, 3 and 5). From the graph, we comprehend that there is a large change of the MSE values from the decomposition level 1 to level 2 but from the level 3 to level 5, there is no change. Hence the iteration is stopped at the level 5. Figure 5 focused on the performance of Peak Signal to Noise Ratio (PSNR) with respect to Compression Ratio (CR) of Daubechies (db2) wavelet filter based on the various levels of decompositions (Level 1, 2, 3 and 5)

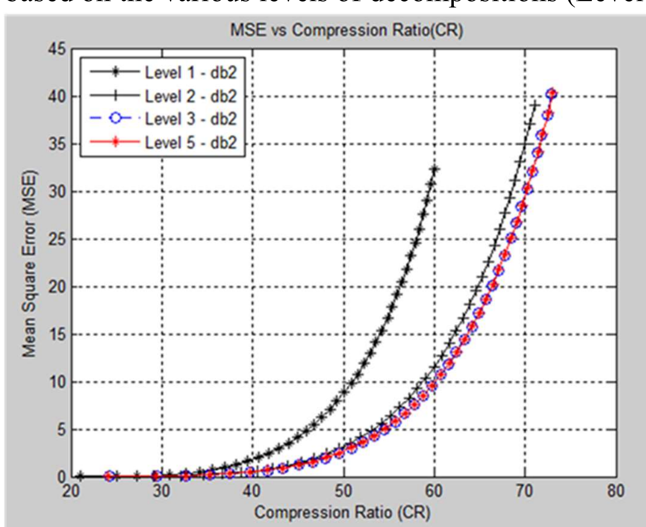

Fig 6 Performance of Mean Square Error (MSE) with respect to Compression Ratio (CR) of Daubechies (db2) wavelet filter based on the various levels of decompositions (Level 1, 2, 3 and 5)

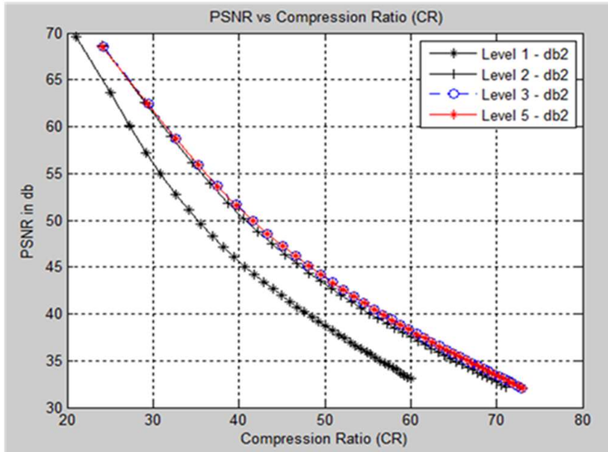

Fig 7 Performance of Peak Signal to Noise Ratio (PSNR) with respect to Compression Ratio (CR) of Daubechies (db2) wavelet filter based on the various levels of decompositions (Level 1, 2, 3 and 5)

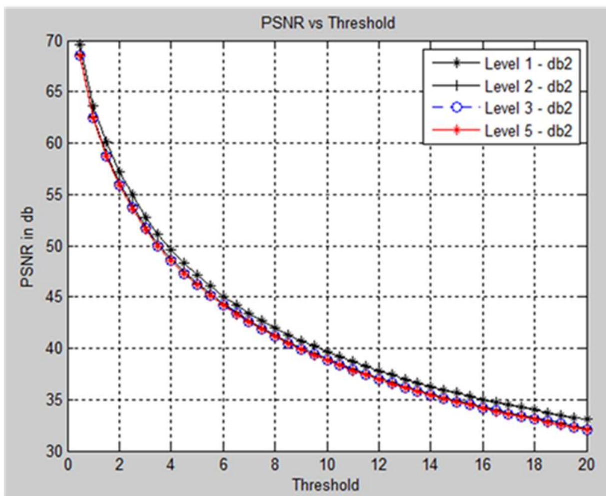

Fig 8 Performance of Peak Signal to Noise Ratio (PSNR) with respect to Threshold of Daubechies (db2) wavelet filter based on the various levels of decompositions (Level 1, 2, 3 and 5)

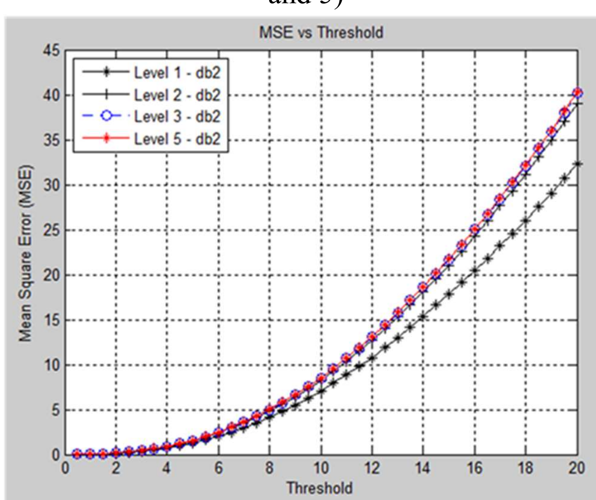

Fig 9 Performance of Mean Square Error (MSE) with respect to Threshold of Daubechies (db2) wavelet filterbased on the various levels of decompositions (Level 1, 2, 3 and 5)

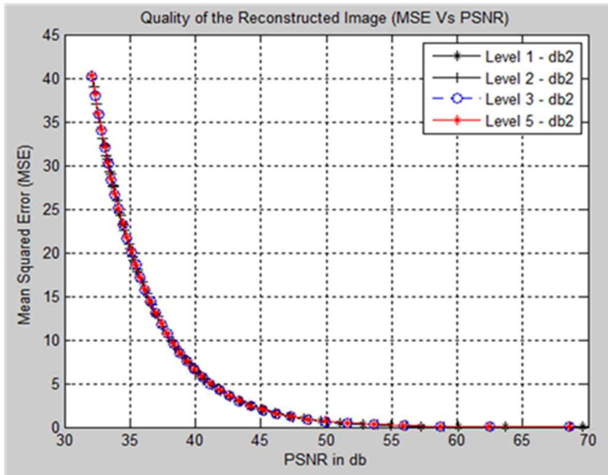

Fig 10 Performance Analysis of Mean Square Error (MSE) with respect to Peak Signal to Noise Ratio (PSNR) of Daubechies (db2) wavelet filter based on the various levels of decompositions (Level 1, 2, 3 and 5)

The performance of Mean Square Error (MSE) , Compression Ratio(CR) with respect to Threshold ofDaubechies (db2) wavelet filter based on the various levels of decompositions (Level1, 2, 3 and 5) are depicted from the above diagrams (Fig 5– Fig 10). It clearly shows that there are no significant changes of the MSE values after the decomposition level 3 to 5.

6. CONCLUSION

In this proposed hypothesis, we have implemented a hybridalgorithm for medical image compression based onDaubechies wavelet, global thresholding, and Huffmancoding. In our experiment, we have investigated the trade-off between quality of the reconstructed imageand number of decomposition levels of the waveletfilter. The performance of the image coder is evaluatedbased on the PSNR obtained. In earlier research work [73] concluded that the coding efficiency is contributed by the first five levels of decomposition of the wavelet filter. In theory, a wavelet-based compression techniques candecompose the image to any desired level but in practice it is not feasible due to high computational time. Motivation of this research work is to investigate the trade-off between the number of levels of image decomposition and quality of the reconstructed image.

Our research results also proved its consistency that quality of the coder is not significantly changed from the third level to the fifth level of wavelet decomposition. Based on the above investigation, we comprehend that it would be reasonable to use the first three levels of decomposition for better performance of image compression on medical images for time limited computational complexity (practically proved with experimental set ups).

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