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Quality Compression for Medical Big Data X-Ray Image using Biorthogonal 5.5 Wavelet

Fadia Shah*, Prof. Jian Ping Li**, Faiza Shah***, Yasir Shah****
**(School of Computer Science, UESTC, Chengdu, China.*
Email: fadiashah13@yahoo.com)
***(School of Computer Science, UESTC, Chengdu, China.*
Email: jpli2222@uestc.edu.cn)
****(Department of Management Sciences, CUST, Islamabad, Pakistan.*
faizashah55@gmail.com*)*
*****(School of Finance, CUFE, Beijing, China.*
yasirshah_pk@yahoo.com*)*

ABSTRACT
Medical Big Data (MBD) consists of very useful type of information. It is very important for a physician for decision making and treatments to cure the patient. For accurate diagnosis, data availability is the most important factor. MBD over network needs intelligent compression schemes so that it is transferred to the destination by utilizing available bandwidth. Biorthogonal 5.5 Wavelet Compression scheme compress the MBD without losing the important information, thus making the information reliable and less in size; transference by efficient bandwidth utilization from source to destination.

Keywords **–** Biorthogonal Wavelet Compression, Medical Big Data, Lossless Compression.

I. INTRODUCTION

Medical big data (MBD) contains a large number of files and data including medical images, ECG [3], reports, videos, x-rays and automated systems [2]. Body screening can be imprinted by X-Ray images. Such data needs huge space to store and is important for future use. Over a huge Wireless Network (WN) [7], more bandwidth utilization slows down the network traffic or in worst case it may cause deadlock which results in network failure. To reduce this load, MBD volume can be reduced upto a certain level. MBD compression [1,5] can be done efficiently using Discrete Wavelets Transformation (DWT) [7], [5] and Multi-Wavelets (MW) [6]. Such type of image compression is called Lossless Image Compression (LIC) where specific and most important information is compressed without loosing any of the detail. The image [4] is not only reduced in size but also quality of information is ensured by reconstructing the image as exactly as original. This is very useful for efficient bandwidth utilization.

Sophisticated MBD focusing specific portion [14] of the x-ray, in order to get reduced error chances, the complete image is compressed. In this regard, some least useful data is not compresses which results in reduction of the size of images. Small size data files can be transferred easily over the Wireless Network within the available bandwidth utilization. lossless [16] Wavelet implementation is carried out using various Wavelet techniques [18]. Usually most well known and popular are Haar, Daubechis, Orthogonal, Biorthogonal etc. There are implemented using schemes [1] and methods [2].

Usually in emergency conditions and sometimes even in normal conditions, when a patient consults for treatment, entire medical record availability is needed which is rarely happened. The fig1 describes the MBD from huge file towards less size file. The x-ray image is converted into machine recognizable form, it is de-noised and compressed by extracting coefficients and making the original image by using these coefficients. There is a noticeable difference in both the original and reconstructed file. A small piece of information in medical consultation can save one from a huge loss.

Fig 1 : MBD Analysis using Biorthogonal Wavelets

That is why the MBD in any particular form is very important to maintain and store efficiently. Data availability schemes are implemented in hospitals, over the network and still it is being worked to improve data availability when needed. And often this information is maintained in Cloud architecture by a number of smart schemes. To make this information available for further use, wavelet compression plays very important role.

The figure 1 describes the medical big data X-Ray file as raw data file, the mathematical function using wavelets will denoise and reduce the useless data, here the fie size will reduce upto certain level. The the file is further compressed and this results in reduction of the file further at maximum level. This results the wavelets refined image and coefficients. Through this way, the MBD is reduced and is made useful for further use. This makes the data breakup into different frequency components.
The retained energy is 100%, SNR and CR values are also mentioned which ensure image quality

II. X-RAY IMAGE COMPRESSION VIA BIORTHOGONAL 5.5 WAVELET COMPRESSION

X-Rays are electromagnetic radiation. When such radiations are bombarded on photographic plate, the dense particles block radiations forming white image and lighter ones make black image. This produces x-ray images. After the historic discovery of X-Rays; there opened a new door in the field of science, medicine and technology. X-rays are the most important and widely used methodological tool in accurate medical diagnosis. Since then, the orthopedic medical related problem diagnosis is very much dependent upon X-ray images. Either it is fracture, bone infections, abnormality identification, oral complications and many more are very famous applications of X-rays. With the advance innovations in technology, like upcoming 5G, sensors, IoT, smart devices, automated and sensitive medical equipments, the MBD sources are rapidly increasing. Biorthogonal image compression for X-Ray image is lossless compression scheme and uses liner functions for coefficients. That is the reason it is being adopt more with the passage of time.

III. MEDICAL BIG DATA AND WAVELET COMPRESSION

Wavelets functions are based upon the concept of Approximations using the positioning of functions. This way it facilitates the frequency domain information to analyse in time domain also. The proposed paper describes DWT compression using Biorthogonal Wavelet 5.3 family implemented on X-Ray image. The central concept is the outstanding Wavelet Compression for upcoming technological benefits with MBD. X-ray images like, dental, arms, foot etc contains necessary information for a specific disease or problem identification like fracture, abnormality. Un identification may lead severe complications. The chest, dental and head x-ray importance could be considered as for example about dental, Many pigmentation, tumors and cavities can be identified by x-ray images. So, every body part X-Ray is important for diagnosis of medical problems.

Wavelet Transformation is comparatively a new field which consists of mathematical functions. With its implementation in image and video compression, there are many research areas related to this. Although there are also a number of compression schemes, for image compression, JPEG is famous one, but wavelets have better impact due to its analysis functions in time as well as frequency domain observations. For most of the schemes, negligible changes within the data cannot be identified but with wavelets it can be observed very efficiently. Many Wavelet Compression algorithms have been implemented and more are being developed to reduce the size of file and remarkable MBD based activities.

The Wavelet compression after the completion of every level generates some coefficients. The correlation coefficients measure the dependence of two adjacent variables at a certain variable. This is also obvious that at the completion of every level, the noise is removed. The coefficients for image compression and reconstruction are calculated by the following mathematical formula

$$r = \frac{n(\sum_{i=1}^{n} X_i Y_i) - (\sum_{i=1}^{n} X_i)(\sum_{i=1}^{n} Y_i)}{\sqrt{[n(\sum_{i=1}^{n} X_i^2) - (\sum_{i=1}^{n} X_i)^2][n(\sum_{i=1}^{n} Y_i^2) - (\sum_{i=1}^{n} Y_i)^2]}},$$

The images apparently can be seen the practical implementation of reliability of compression scheme. In fig 2, there are some classifications of Biorthogonal family along with their scaling functions.

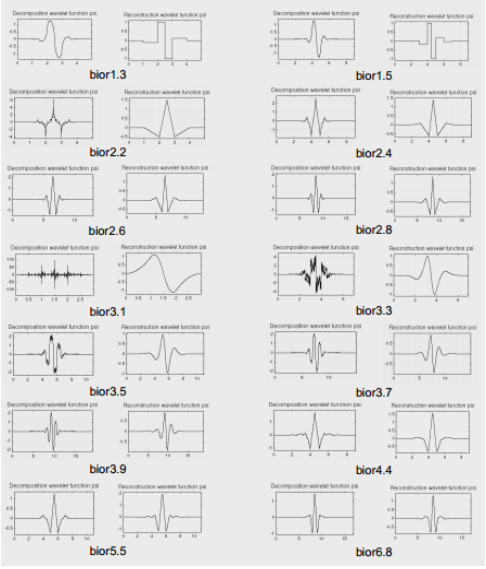

Fig 2: Biorthogonal Wavelet Family along with scaling functions

IV. ALGORITHM

1. Load (image) and Insert into array [size]
2. While{decomposition upto Level N}
3. Biorthogonal Wavelet Analysis
4. Calculate N;
5. Hard Threshold (N Level detailed coefficients)
6. Coefficients Remove
7. Coefficients Reconstruction
8. Original and Reconstructed image comparison
9. End
10. Statistical Quality Measurement

V. QUALITY MEASUREMENT

The image quality measurement parameters are signal to noise ratio and specifically the compression ratio

PSNR= $$20\ log_{10}\frac{2^{N-1}}{RMSE} \quad (db)$$

The difference between two image is calculated by root mean square error (RMSE). For original image '**x**' and compressed image '**y'**, MxN (rows x columns matrix).

RMSE = $$\frac{1}{MN}\sum_{m=0}^{M-1}\sum_{n=0}^{N-1} |\ y(m,n) - x(m,n)\ |^2$$

The Compressio Ratio determines the quality of image. It is the ratio of original and compressed image.

C.R. = $$\left(\frac{Number\ of\ bytes\ of\ Original\ data\ set}{Number\ of\ bytes\ of\ Compressed\ Data\ set}\right)\times 100$$

This way the image quality ensures image reliability. Table1 shows the image, original image is the image raw file and (Wavelet) compressed image. It is observed that there is almost negligible difference between both the files. This means the imag information is not lost.

Image	Original Image	Compressed Image
Img 1		
Img 2		

Table1: Biorthgonal Wavelet Compression Original file (left) and compressed file (right)

II. Results and Discussions

The Wavelet Biorthogonal family 5.5 is implemented till level 5 to three different images.

Image	Retained Energy	Zeros	SNR	Compression Ratio
Img 1	100%	52.94%	52.66	192.3%
Img 2	100%	82.56%	52.14	183.33%

Table2: Statistical analysis of X-ray image quality

The X-Ray image in original image and the image formed after Biorthogonal Wavelet Compression scheme can be observed in the table below. It describes the statistics ensuring the image reliability. The retained energy is 100%, SNR and CR values are also mentioned which ensure image quality. More the C.R means more the reliable information.

III. CONCLUSION

MBD Compression using Wavelet is a fast growing technique. In DWT, there are number of Wavelet families which are efficient for MBD image compression. The compressed image contains all the components as that of the original image with less size. It is very efficient in digital signal processing and digital images specifically MBD. This reduced size image can be transmitted over the destination using any infrastructure.

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