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Application of Discrete Wavelet Transform for Compressing Medical Image

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Abstract: **There are calls for enhancing present healthcare sectors when it comes to handling huge data size of patients' records. The huge files contain lots of duplicate copies. Therefore, the ideal of compression comes into play. Image data compression removes redundant copies (multiple unnecessary copies) that increase the storage space and transmission bandwidth. Image data compression is pivotal as it helps reduce image file size and speeds up file transmission rate over the internet through multiple wavelet analytics methods without loss in the transmitted medical image data. Therefore this report presents data compression implementation for healthcare systems using a proposed scheme of discrete wavelet transform (DWT), with capacity of compressing and recovering medical image data without data loss. Healthcare images such as those of human heart and brain need fast transmission for reliable and efficient result. Using DWT which has optimal reconstruction quality greatly improves compression.**

Keywords: **Discrete Wavelet Transform (DWT), Image Compression Medical Image.**

I. INTRODUCTION

Patient monitoring in health connected topic is becoming important issues in healthcare domains and beyond. Tele-monitoring is the latest medical modernization which deploys internet technology monitoring patient body's symptoms independently. Health monitoring platform renders effective Medical tools in monitoring of diseases especially ageing populace [1]. Patient medical supervision reduces risk infectious diseases spreading and also minimizes hospitalization cost. Heath monitoring enhances the predictability of life frightening illnesses, and institutes an alarming mechanism for catastrophic scenarios where prompt treatments are delivered saving death rate [2].

Several establishments such as hospital-care, prison-care, space-care, and clinic-care [3] exploit health monitoring platform to relentlessly monitor in real-time. This eases hospitalization time and cost, augmenting user's day-by-day schedule while been monitored by healthcare experts.

Health monitoring systems removes limitation on mobility with improved quality for healthcare sector [4]. The use of DWT and similar technique greatly decrease size of medical gadgets through compression and make its implementation extra demanding for health monitoring applications.

Our experimental implementation shows that using Haar wavelet with parametric determination of MSE and PSNR solve our aims. Many imaging techniques were also deployed to further ascertain DWT method's efficiency such as image compression and image de-noising. The proposed compression of medical image was excellent.

II. IMAGE COMPRESSION AND RESTRICTION

Image Compression reduces image size (storage) and speedup transmission rate. It has two basic structural entities; encoder and decoder. An image f (x, y) enters encoder producing set of input data to epitomize image. The approximation image f '(x, y) is attained by compressing and de-compressing the image.

Compressing image is essential because, most images contain artifacts demanding huge storage capacity and high financial cost. Compression helps eliminate redundancy, reduce transmission rate, and subsequently lesser storage space to accommodate many image signals.

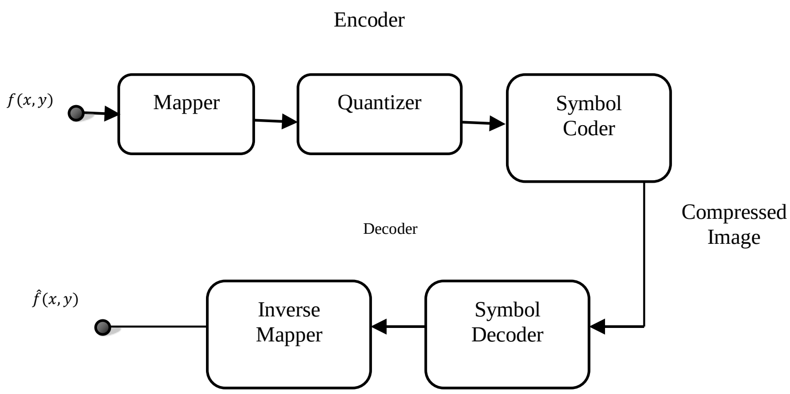

Figure 1: Image Compression Systematic Phases

Several compression performance indexes [8] are used to simulate the effectiveness of the compressed sample.

$$C_R = \frac{n_1}{n_2} \qquad (1)$$

C_R is Compression ratio, n_1 is the original image and n_2 is the compressed or processed image.

Example, the CR 80:1 means the source image has 80- bits per unit in the compressed data.

Mean Square Error (MSE) is used to show the efficiency of the reconstructed image in respect of the original image.

$$MSE = \frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}[f(x,y) - \hat{f}(x,y)]^2 \qquad (2)$$

Note, MSE is mean square error,

M = Image rows,

N = Image columns.

$$PSNR = 10\log_{10}(255^2/MSE)dB \qquad (3)$$

PSNR and MSE measured in Decibel.

III. WAVELET TRANSFORM

PAS become popular in Sierra Leone after the civil war. Many Wavelet is a mathematical function that reduces and partition data into many sub-band frequencies [5]. This method is necessary as biological records are investigated on diverse scale or resolutions called mutiresolution, and allows mutiresolution decomposition [6]. DWT has predominantly dominated medicare image compression field lately due to its recovering capability for image compression successfully with many mother wavelet representations. DWT coefficients are almost put to zero fluctuating up and down along the x-axis, and contain compact signal formation ensuring our image is not over obtainable with many equals zero making the algorithm more reliable for better recovering. Wavelet function $\Psi(t)$ contains two main features [7];

$$\int_{-\infty}^{0}\Psi(t)dt = 0 \qquad (4)$$

For oscillatory function or wavy situation.

$$\int_{-\infty}^{0}|\Psi(t)|^2 dt < \infty \qquad (5)$$

Majority of energy in $\Psi(t)$ is partial to finite periodicity.

Proposed Image Compression Scheme using DWT

This unit presents the proposed compression scheme using the discrete wavelet transform. It initially decomposed the image into coefficients known as sub-bands and then compares the coefficients with a threshold. Coefficients below the set threshold are put to zero and those above are encoded with a lossless compression scheme.

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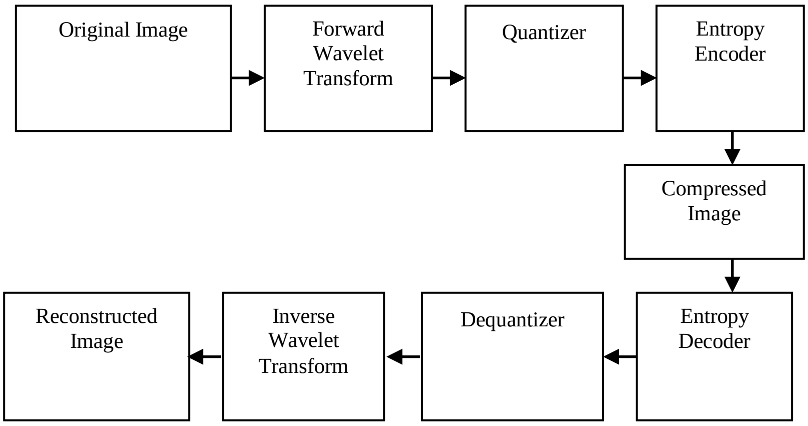

Figure 2: Structure of the Wavelet Transform Compression Scheme

Table 1: Wavelet Image compression and decompression a medical image in Matlab domain

Algorithm: DWT Image Construction and Decomposition
Lunch Matlab and open the wavemenu toolbox
Load the image named brain.jpg with resolution 153 x 150
Choose biorthogonal wavelet type with 1.3 ratio and then select level 3.
Click analyzes and select compress.
Use "By level thresholding" and select "Balance Sparsity-norm under thresholding method. Also select "Horizontal detail coefficients".
Click compress and save the image.

IV. EXPERIEMENTAL RESULTS AND DISCUSSIONS

A DWT scheme was applied using Matlab functions to perform the proposed algorithm. Figure 2(a,b,c)

a. Source Sample

b. Compressed Sample

c. Reconstructed Image

Table 2: Results obtained for figure 2.

DWT Level	Threshold Values
Level 1	250.1
Level 2	481.7
Level 3	935.3

Figure 2, (a) is source picture, (b) is compressed sample and (c) is reconstructed image. Energy was preserved in compressing and decomposing image to 99.93% with 76.98% zeros.

Table 3: MSE, PSNR and CR values of different performance indexes for Brain

Wavelet Type	MSE	PSNR	CR
Haar	60.25	30.33	10.9167
Bior	60.25	30.33	10.9167
Coif	58.89	30.43	9.7300
Sym	59.03	30.42	9.6324

Table 3 shows the comparisons among three different performance indexes using brain scan for four different wavelet types. Our result shows that coif had better MSE and PSNR than the other wavelets but sym has an optimum compression ratio.

Table 4: Comparison of DWT compression schemes

DWT Compression Types	Original Image	Compressed Image	Compression Ration	Mean Square Error	PSNR
Haar	92.0 KB	70.5 KB	1.3050	4.85	41.27
Bior	92.0 KB	71.3 KB	1.2903	10.04	38.11
Sym	92.0 KB	72.2 KB	1.2742	8.09	39.05

Table 4 shows results of image sample with resolution 640 x 640 and size 92. 0 KB in JPEG format for three wavelet types. The wavelet type (sym) proves better compression ration than Haar and Biorthogonal wavelets. But our experiment further tells us that Haar has superior error with peak signal to noise ratio corrections than the two wavelet types.

The experimentation adapted better reconstruction scheme is faster and effective several times than the conventional compression-based algorithms.

V. CONCLUSION

The proposes a compression scheme called DWT for compressing medicare images, with high quality. They remove computational complexity compared to traditional image procession schemes. This is significant for medical imageries; i.e.; brain pulse, heart rate which needs accurate details before treatment. The exploitation of DWT with minimal power wavelet technique greatly reduced on-chip computing resources relating to energy exploitation and gadget size. It was far superior and outperformed other image compression algorithms about five (5) times effective.

FUTURE WORK:

Exploiting other wavelet-based image compression like Daubechies' wavelet is fundamental for future research direction. Future work engross enhancing medical image quality by increasing PSNR value, lowering MSE value and using other metric such as percentage root square distortion(PRD).

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