Powerful Image compression technique on medical images

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ABSTRACT-The digital image and its usage have increased may fold as the capability and utility of computers and networks have been increased rapidly. Against this background, there comes the need for improving image compression algorithms. Professional fields like medical imaging need acquiring huge amount of data every day and as a result of which compression reduces the file size. compressing data can save storage capacity, speed the file transfer and will decrease the costs for storage of hardware and network bandwidth.The need for an efficient image compression technique ever increasing because of the transmission & storage. For transmitting medical images over the internet,huge bandwidth is necessary.Number of images per diagnosis and resolution factor evenfor single patient makes the size of the images very large. So in compressing these medical images, there is an immense need for efficient compression techniques. For a given medical image noise is applied and noisy medical image is obtained. Noisy medical image is preprocessed with denoising technique then compressed. Compressed image is reconstructed then it is postprocessed and the result is compared with noisy image and picture quality parameters such as PSNR, MMSE, SSIM and ER, are obtained with extremely improved values. This paper deals scaling and hardthresholding techniques with HWT and highly acceptable compression ratio is achieved.

Keywords –Haar wavelet Transform, hard thresholding, scaling, adaptive median filter, entropy coding

I INTRODUCTION

An important area of biomedical engineering, especially for telemedicine are analysis and compression of medical images. Use of this will play a major role for diagnosis of sophisticated and complicated images through consultation. Transmission over networks at large distances for the use of telemedicine through medical image, it is necessary that they must be transmitted in compressed and secured form for the reliability.

Modern X-ray equipments (modalities) are introduced for use in the x-ray departments nowadays. These new scanners cannot exhibit films directly. On with the traditional x-ray equipments, the output results of mathematical calculations on signals detected during the scanning. The result from such scannings are digital images of the patients rather than analogue images. In the most traditional examinations the directly exposed films are not appearing.otherside,Plates of phosphor or selenium are put behind the patient, exposed with x-rays and subsequently put it in a reader along with the assistance of a laser beam converts the latent image toa digital signal. These digital images are forwarded to the above called laser cameras which print them out on film.

Data bases will have all these digital images instead of printing them on films. Actually this can be done but the number of PACS replacing fully the film based archives are few world wide and for several reasons. A medium size hospital with 50,000 X-ray examinations per annum produce equivalent of Three to four gigabyes per day. The health authorities may normally want some years production is recorded. For example in Denmark, national board of health stipulates that 5 years production has to be stored. It is very difficult to hookup digital X-ray equipment into network for image distribution and archival due to the lack of standards. As majority of the few completely filmless departments in the world is set up with equipment from only one vendor, X-ray devices, network, archive, everything result a very inflexible and also very expensive solution.

Remedial of the situation has come from major advances during the last few years. Readily availability of ATM networks starting at 155 megabits per second and also as well as network adapter for workstations, PC‘s and MAC‘s are found now. Defining of an internationally approved, complete protocol for medical image communication DICOM exists. Possibility for choosing the different component from different vendors based on a department completely on this standard. Archives capacity is still a problem. It is very costly to achieve decent performance. Solution will be in image compression even this problem is solved. Several

algorithms like predictive coding, sub-band coding, vector quantization, segmented image coding, neural networks and fractal coding have been proposed in the literature until now.The wavelet transform has got significance due to its manifold characters like high compression ratio, lossless to lossy, multiresolution in nature and applicable to various medical images.
Any noise like _Gaussian noise‘ or _salt and pepper noise‘ or _moisture noise‘ or _speckle noise‘ is added with a given medical image and noisy medical image is generated. Adaptive median filter is helping in the preprocessing of noisy medical image. Incompressed part, preprocessed medical image is partitioned into 8x8 blocks of pixels. For each and every block, gamma scaling with HWT and entropy coding is applied to obtain compressed image. The objective parameter CR is computed for compressed image. In compared with input noisy medical image and picture quality parameters like PSNR, MMSE, SSIM, ER, are taken along with extremely improved values.

II RELATED WORK

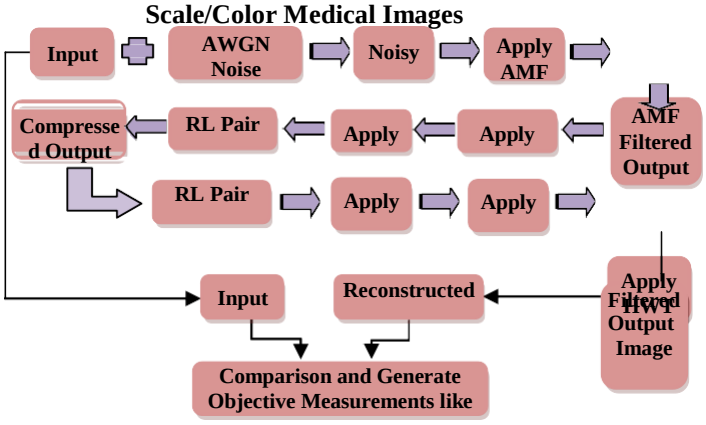
Sukhwinder Singh, Vinod Kumar, H.K. Vermahas Jointly proposed a novel technique for medical image compression called adaptive threshold-based block classification. As the result of this, CT, an X-ray and ultrasound image are used to evaluate the performance and compares the derived results to the JPEG respective to the quality indices. [1]

J. Jyotheswar, SudiptaMahapatra has proposed a paper on efficient FPGA implementation of DWT (Discrete Wavelet Transform) and modified SPIHT (set partitioning in hierarchical trees) for lossless image compression. As the result shows that, the algorithm promotes good compression ratio and better peak-signal-to-noise ratio (PSNR) with 3D medical images. [2]

A new technique of 3D wavelet transform was proposed by Gregorio Bernabe, Jose M. Garcia and Jose Gonzalez for medical videos . Result shows, a good compression ratio and a good quality of the reconstructed video. Also when comparing this scheme with MPEG-2 and EZW, promotes better compression ratios of 119% and 46% respectively for the same PSNR

decompression part, run length decoding followed by inverse thresholding along with upscaling, IHWT is applied on compressed image. Finally adaptive median filter as post-processing filter is applied on decompressed medical image to improve picture quality. Post-processed image of Decompressedmedical image is the peak signal-to-noise ratio (PSNR) value. [4]

III Image Compression-Decompression For Gray Scale/Color Medical Images



Yen-Yu Chen has designed a novel medical imagecompression technique called DCT(Discrete CosineTransform) based subband decomposition and modified SPIHT (set partitioning in hierarchical trees) data organization. Results showed that the quality of the reconstructed medical image has been

Figure 1Block Diagram of Image Compression-Decompression

An Gray Scale is taken Salt n Peppers Noise generator generates with range of Sigma value from 0.1 to 0.05.generated noise is added to the original brain image and salt n pepper noisy image is obtained as shown in figure 6.2.Adaptive Median filter is applied to the noisy image and filtered brain image is obtained as shown in figure 3.A preprocessed AMF filtered output image is taken and partitioned into 8x8 pixels.For every block of 8x8 matrices, HWT is applied and coefficient matrix is obtained.scaling techniques with high factor – Ngamma is applied on HWT output matrix.Hardthresholding is applied to scaled HWT output matrix.Entropy Coding is applied to scaled,thresholded HWT output and compressed output is obtained.

Run length decoding is applied on compressed output.Non-zero elements of the compressed stream are obtained and the better compression ratio is evaluated with reference to original stream. Inverse Hard thresholding followed by upscaling is applied on decoded output. Inverse HWT is applied on Inverse hardthresholded , upscaled, decoded output to reconstruct the compressed image.Reconstructed image is postprocessed with Adaptive median filter.Decompressed , postprocessed image is compared with noisy image to compute objective measurements parameters.Steps 1 to 15 are depicted iblock diagram as shown in figure 1. It is verified that Ngamma high factor provides best possible reduced number of digits for gray scale.Conventional Run Length pair decoding is applied to the compressed stream.Inverse Hard threshold is apply then Inverse HWT is applied followed by AMF and obtained reconstructed output image.It‘s ensured that this technique is providing better compression ratio and better image quality.It also ensured for all other noises like AWGN, Random Noise and Speckle nois**e.** It also applicable for different image file formats like jpeg, bmp, tiff, etc**.**

IV RESULTS AND DISCUSSION

Salt n pepper is added with original grayscale brain image in figure 2(left), and Salt n pepper noisy grayscale brain image is generated as shown in figure 2(right) in which original grayscale brain image is compared with salt and pepper noisy grayscale brain image and objective measurement parameters are computed as PSNR=24.1446,MSE = 251,ER=0.993472 , SSIM=0.048611

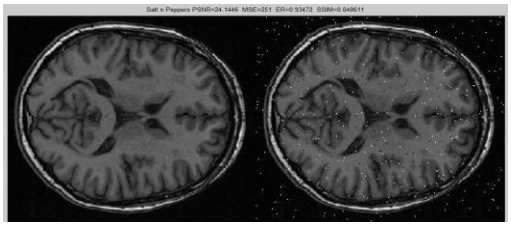


Figure 2 original Image Vs Salt n Peppers Noisy Image

In comparison of Original grayscale brain image with Salt n Peppers grayscale brain image Noisy Image, poor picture quality parameters are obtained. So preprocessing is needed for noisy grayscale brain image.

In comparison of Salt n Peppers Noisy grayscale brain image in figure 3(left) with AMF preprocessed grayscale brain image as shown figure 3(right) good image quality parameters are obtained as PSNR value is increased from 24.1446 to 56.427,MSE value reduced from 251 to 116, ER value increased from 0.93472 to 1.0377 which is near to 1, SSIM value also increased from 0.048611 to 0.94495 which is also near to 1.

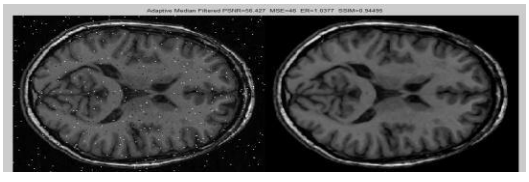


Figure 3 Salt n Peppers Noisy brain Image Vs preprocessed brain Image

Block of 8*8 matrix of preprocessed gray scale brain image as specified in table 6.1 is inputted to HWT and HWT output coefficients are obtained as shown in Table 2 in which Ngamma scaling/hard thresholding is applied and Ngamma Scaled HWT Output Block is obtained as shown in table 3. Entropy coding comprising of Zigzag scanning followed by conventional run length encoding is applied on table 3 and compressed output is obtained as shown in table 4

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Table 1 HWT Input Block brain image

97	94	94	96	96	96	96	96
97	97	98	98	98	97	96	96
96	97	97	98	98	98	96	98
89	91	94	97	98	99	99	99
83	85	89	93	96	98	99	99
79	81	83	86	89	93	96	99
73	74	75	79	86	89	94	96
66	68	72	75	79	87	93	96

Table 2 HWT Output Block brain image

382.5	389	-3.5	1	1.5	-1	0.5	0
315.25	372.25	-10.75	-13.75	-1.5	-2	-0.5	-1
3	-3.5	3	0.5	-2	-3.5	-3	-1.5
24.25	12.25	-0.75	5.25	-1.5	-3.5	-5.5	-2.5
-1.5	-3	-1.5	0	1.5	-1	-0.5	0
6.5	2	-0.5	-2	0.5	1	0.5	-1
4	6.5	6	1.5	0	-0.5	1	1.5
6.5	3.5	4.5	0.5	0.	-	2.	0.

				5	0.5	5	5

Table 3 Ngamma Scaled HWT Output Block of brain image

48	49	0	0	0	0	0	0
39	47	0	0	0	0	0	0
0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

No. of digits=11

Output after Entropy coding comprising of zigzag scan and conventional run length encoding is shown in table 3. In table 3, top left first digit is considered as DC coefficient and remaining digits are considered as AC coefficients. In zigzag scanning , number of zeros occurred between two non-zero digits are computed as length of runs. Length of runs followed by non-zero AC coefficient is considered as pair of run length. 5 pairs of run length is added with one DC coefficient and 11 digits are obtained as compressed output block of coefficients as shown in figure 4.

Table 4 Entropy coding output of Ngamma scaled HWT output Matrix

(0,49)(0,39)(1,47)(4,3)(0,0)

Run length decoding is applied the Entropy coding output in table 4 and decoded output is obtained as shown in table 5 and inverse hard thresholding followed by upscaling is applied on table 5 and output is obtained as in table 6 on which Inverse HWT is applied and decompressed output is obtained as shown in Table 7.

Table 5 Decoded Output Block of 8*8 Matrix of gray scale brain image

48	49	0	0	0	0	0	0
39	47	0	0	0	0	0	0
0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Table 6 Inverse thresholded,Upscaled decoded Output of brain image

96	96	96	96	98	98	98	98
384	392	0	0	0	0	0	0
312	376	0	0	0	0	0	0
0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Table 7 IHWT Output Block ofbrain image

96	96	96	96	98	98	98	98
96	96	96	96	98	98	98	98
96	96	96	96	98	98	98	98
84	84	84	84	94	94	94	94
84	84	84	84	94	94	94	94
72	72	72	72	94	94	94	94
72	72	72	72	94	94	94	94

After compression and decompression, degraded image is obtained. So still post processing is needed for degraded image. AMF is applied on the degraded image and AMF postprocessed image is obtained as shown in figure 4(right). In comparison of Salt n Peppers Noisy grayscale brain image in figure 4(left) with preprocessed, decompressed , AMF post processed grayscale brain image, very good image quality parameters are obtained as PSNR value is increased from 24.1446 to 76.4047,MSE value reduced from 251 to 77, ER value increased from 0.93472 to 1.0546 which is near to 1, SSIM value also increased from 0.048611 to 0.8746 which is also near to 1.

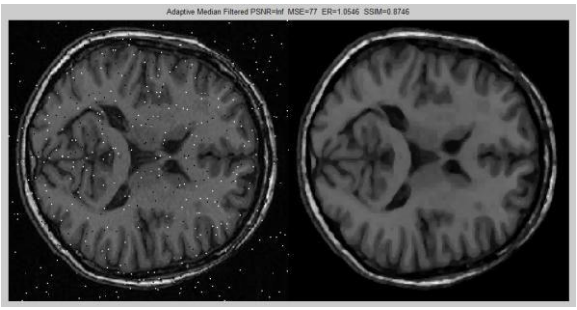

Figure 4 Salt n Peppers Noisy brain Image Vs decompressed,postprocessed brain Image

Similarly , this Compression-Decompression algorithm applied for color brain image also and output is obtained as shown in figures 5,6,7. Block of 8x8 matrix of preprocessed color brain inputted to HWT and HWT output coefficients are obtained on which Ngamma scaling/hard

thresholding is applied and Ngamma Scaled HWT Output Block is obtained then Entropy coding comprising of Zigzag scanning followed by conventional run length encoding is applied on table and compressed output is obtained. Then decompression is applied on compressed color brain image and output is analysed in table 8.

By this analysis it is observed that in preprocessed, Decompressed, postprocessedgrayscale image the PSNR is highly acceptable value 76.4047 preprocessed, decompressed, postprocessed color image the PSNR is highly acceptable value 74.4047 great compression ratio 0.171875 by using scaling and thresholding technique with haar wavelet b compression.

Figure 5 original color brain Image Vs Salt n Peppers Noisy color brain Image

Figure 6 Salt n Peppers Noisy color brain Image Vs preprocessed color brain image

Figure 7 Salt n Peppers Noisy color brain Image Vs decompressed, post processed color brain image

Grayscale and color CT brain image are taken for the compression. In the scaling technique and hard thresholding with HWT based image compression , best Compression Ratio is achieved up to 0.171875 for both CT grayscale and color brain images with image quality parameters PSNR, MSE, ER and SSIM and shown in table 8.

Table 8 Performance parameters of grayscale and color brain image

Noise Type /Filters	PSNR	MSE	ER	SSIM
the Grayscale and Color Brain Image in Medical Application				
rain Original grayscale brain image Vs Salt n Peppers grayscale brain image Noisy Image	24.1446	251	0.93472	0.048611
and rain Salt n Peppers noisy grayscale brain image Vs AMF preprocessed grayscale brain image Image	56.427	116	1.0377	0.94495
for hard ased Salt n Peppers grayscale brain image Noisy Image Vsdecompressed,AMFpostprocessedgrayscale brain image Image	76.4047	77	1.0546	0.8746
Original color brain image Vs Salt n Peppers noisy color brain image	24.6375	224	0.99663	0.031895
Salt n Peppers noisy color brain Image Vs AMF preprocessed color brain image	46.9018	215	1	0.95786
Salt n Peppers noisy color brain image Vs decompressed, AMF postprocessed color brain image	74.4047	197	0.89359	0.9157

V CONCLUSION

Compression ratio was estimated for grayscale and color brain image with Ngamma Scaling technique and it was proved that Ngamma Scaling with Haar wavelet Transform have given good compression ratio. While testing performance of compression and decompression algorithms in medical applications, it was ensured High compression ratio was achieved along with good visual quality of imageas compared to DCT. Adaptive median filter gives good visual quality with high PSNR value in both preprocessing and post-processing during compression and decompression of medical images. Thus this work is useful very much in fast transmission of medical images with less storage space and less bandwidth.

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