

Survey of CROI based Compression on Grayscale Medical Image of Fetus

Sejal Thakkar¹

Computer Engineering Department, Indus Institute of Technology and Engineering, Indus University. Ahmedabad.

seju101ster@gmail.com Mob.no.. 9033380982

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Abstract— Sometimes from the whole image we need only some part of Image is required for Diagnosis purpose by the doctors. Fig1.shows combined images original baby picture with the picture of it's color ultrasound medical image. My work focus on grayscale uncompressed ultrasound medical image of Fetus. Aim of ROI compression for Fetus images is compressing the important region; region of interest (ROI) required for diagnosis here Position of baby is important region is compressed with supreme quality as compared to rather unimportant area in order to get better compression performance.

As a part of ROI compression technique CROI [4] with JPEG & WAVELET compression algorithm have been implemented on Image fetus.bmp using MATLAB. A detailed analysis on the basis of parameters like CR, MSE, PSNR and COC has been used to evaluate these algorithms. With the use of CROI approach with JPEG algorithm, we get PSNR of 38.22 for image and CROI with WAVELET gives PSNR of 39.82 db with extremely good quality of image area.

Keywords— DWT, ROI, Region of Interest, US, Ultra sound, WAVELET, DCT, JPEG,bior.

I. INTRODUCTION

In old conventional compression model, an entire image is compressed equally, i.e. equal level of compression is applied to the useful area as well as to the non useful or redundant area of an image. so we will get less compression ratio and degrade quality of Image. But sometimes, in Medical image compression in particular, it is desired to preserve the quality of a particular portion of an image more as compared to the rest of the image. The disadvantage of a conventional compression system is that it will compress the entire image with same compression ratio. So we cannot get a good compression performance in case of a conventional compression algorithm.

And that is where a newer concept of compression, called the ROI Compression, arises where the important and unimportant areas of an image are compressed with different compression ratios.

X-RAY and US Medical images comprise of important areas-Region of Interest (ROI), that used for the diagnosis and unimportant area-Background region, which comprises the information and is redundant. The background area in an Ultrasound image is quite large, and we can compress it with quite a large compression ratio as it contains the redundant information. Again we cannot compress the diagnostically important area (ROI) beyond certain CR, in order to retain quality of the reconstructed image.Contextual compression aims at compressing the ROI with the best quality (and least

CR) and compressing the background with poor quality (and highest CR) to attain an overall better compression performance.

The evolution of performance is based on the following parameters [3].

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Correlation-coefficient

$$CoC = \frac{\sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y) \hat{f}(x, y)}{\sqrt{\sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y)^2} \sqrt{\sum_{x=0}^{M-1} \sum_{y=0}^{N-1} \hat{f}(x, y)^2}} \quad (1)$$

on a scale of 0-1. The nearer the value of CoC to 1 the higher the correlation of a compressed image to an Original image is there and vice versa.

Mean Square Error

$$MSE = \frac{1}{NM} \sum_{x=0}^{N-1} \sum_{y=0}^{M-1} \left[f(x, y) - \hat{f}(x, y) \right]^2 \quad (2)$$

Where, $f(x, y)$ is the original pixel value and $\hat{f}(x, y)$ is the compressed pixel value, for an NxM input image.

Peak Signal to Noise Ratio

$$PSNR = 10 \log \left[\frac{(255)^2}{MSE} \right] \quad (3)$$

PSNR related to quality of Image. Peak signal-to-noise ratio, is a ratio between the maximum possible power of a signal and the power of corrupting noise. Higher PSNR would normally indicate that the reconstruction is of higher quality noise is the error introduced by compression.

Compression Ratio

CR= size of original image in bits/size of compressed image in bits (4)



Fig.1.Color ultrasound image of fetus.[7].

II. THE ROI CODING SCHEMES

Using conventional compression methods could hardly achieve the CR of 40 percent for Xray images and that too with much degradation and poor visibility of compressed image. But with contextual compression scheme CR of up to 65 percent are quite achievable with better quality and extremely little degradation of ROI. Some of the ROI coding methods are available [2] here we have analyzed results of various methods and used CROI method with JPEG & WAVELETE compression algorithms.

A. Maxshift method

In the Maxshift method, before bit-plane coding, bit planes of the ROI coefficients are scaled up by the desired amount so that coefficients associated with the ROI are placed in higher bit planes. The scaling factor is selected to ensure there is no overlap between background and ROI bit planes. The entropy coder encodes the code block containing ROI coefficients, the encoded ROI bits appear before the background bits. Then rate control builds a layer progressive bit stream in which information pertaining to ROI precedes that of the background.

Advantage of Maxshift is its fast ROI reconstruction. It also lifts the restriction on ROI shape.

Cons of the Maxshift method include the increased time for coding and background is received only after full ROI reconstruction

B. GENERAL Scaling Based Method

The scaling based method places ROI associated bits in the higher bit planes by scaling the bit planes of ROI coefficients up, coefficients of ROI can be coded first in the embedded bit plane coding.

This method allows the the general scaling based method place ROI associated bits in the higher bit planes by scaling the bit planes of ROI coefficients up, so that ROI coefficients can be coded firstly in the embedded bit plane coding. This method allows the use of arbitrary scaling value and allows fine control on the relative importance between ROI and BG

First, it needs to encode and transmit the shape information of the ROI. This rapidly increases the algorithm complexity. Second, if arbitrary ROI sharps are desired, the shape coding will consume a large number of bits, which significantly decreases the overall coding efficiency.

C. Implicit ROI Coding

The implicit ROI encoding operates as follows. When given a spatial ROI, the relevant code blocks are identified and their contributions are sequenced into the embedded bit stream in a manner that effectively augments the priority of the ROI. Since EBCOT allocates the code block contributions in terms of the overall distortion minimization, the implicit ROI encoding allocates code block contributions in accordance with distortion reduction and the region of interest

Implicit ROI encoding is its low Complexity. The method itself is straightforward and easy to implement. More than that, no bit plane scaling is involved at either the encoding or the decoding side.

Here priority arrangement is made on a block-by-block basis and some ROI code blocks may contain a large amount of BG information. So Weakness is slow ROI reconstruction.

The performance parameters have been discussed in detail by many Authors. The output performance parameters have been analyzed quantitatively and plotted which clearly show the superiority of the proposed method at high compression rates in comparison to the methods CROI Method

Outline of procedure is performed in the CROI compression method [1]. Preprocess an input image Separate out CROI and background. Apply compression algorithms on CROI and Background. Merge compressed CROI and background. Calculate CR and MSE, PSNR and COC of compressed image. This is iterative approach here we have to take iterations until we get the satisfactory Results.

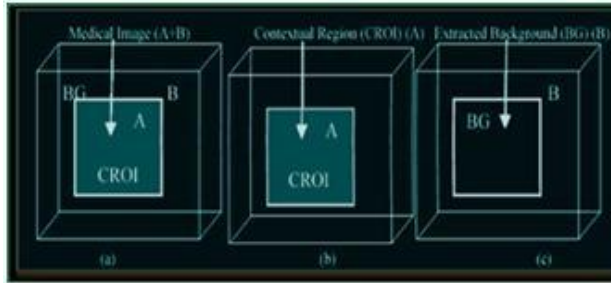


Fig 2.CROI method[1]

III. IMPLEMENTATION PROCEDURE FOR IMAGE (FETUS.BMP)

CROI WITH JPEG Algorithm steps for compression of Medical image

1) Step:-Load the original image to be compressed selectively. Using function like `IMREAD ()`. Pre-processing is performed if required.



Fig 3. Load original ultrasound image of fetus.bmp

2) Step:- Activation of the ROI mask we have to perform to get the selection of ROI. With the use of `ROIPLY()` function we can select a polygonal region of interest within an image. `ROIPLY` returns a Binary image that you can use as a mask for masked filtering. Binary image with and 1's inside the region of interest. 0's outside [6]

3) Step:-ROI mask is activated, the priority adjustment is done so the ROI encoding can be done first and BG encoding can be done later

4) Step: - Now selection of the Contextual region i.e. the ROI is done based on the ROI mask.



Fig 4. Activated Roi mass.bmp

5) Step: - The contextual region (ROI) is separated from the image as per the requirement and set high priority of encoding Using `IMMULTIPLY ()`.



Fig 5. Separated Roi .bmp

6) Step:- Separate the BG form the image and assign low priority for encoding. `IMSUBTRACT()`.



Fig 6. Separated Background.bmp

7) Step:- Encoding of the ROI region is performed selectively with the JPEG algorithm [5] using dct and Huffman coding method [5] with low CR

8) Step: - Encoding of the BG is performed with the JPEG Huffman coding technique with a very high CR.the encoded ROI for merging with BG & encoded BG for merging with the ROI.

9) Step: - Now, Merge the BG and the ROI.

10) Step: - After merging of the ROI and the BG, get the compressed image encoded.



Fig 7. Result.jpg

11) Step: - compressed image may be stored as per the requirement. The reconstruction of the image is done after decoding the compressed image encoded data.

12) Step:- After reconstruction, the image is correlated with original one Decide on the basis of MSE, PSNR and CoC

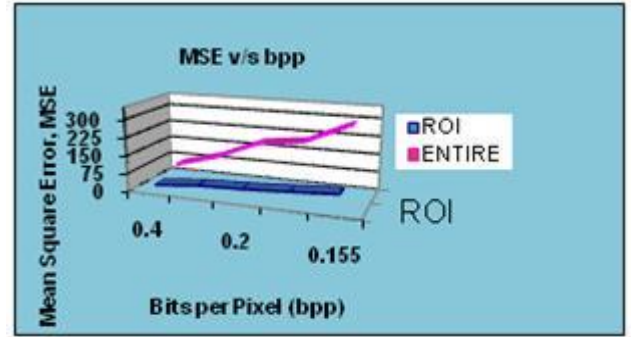


Fig 8.Graphical Representation: Bpp Vs MSE

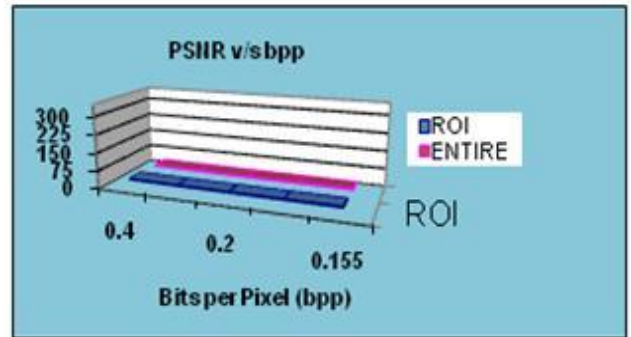


Fig 9.Graphical Representation: Bpp Vs PSNR

IV. PERFORMANCE MEASURING PARAMETERS OF CROI JPEG

TABLE I

ROI and entire image parameters: CR,MSE,PSNR & COC

CROI JPEG PERFORMANCE MEASURING PARAMETERS FOR US MEDICAL IMAGE FETUS							
CR	bpp	MSE		PSNR, dB		CoC	
		ROI	ENTIRE IMAGE	ROI	ENTIRE IMAGE	ROI	ENTIRE IMAGE
20.01	0.40	21.98	58.99	38.22	32.17	0.9989	0.9972
32.01	0.25	39.10	110.18	37.39	29.78	0.9983	0.9951
40.02	0.20	45.13	185.99	35.44	27.49	0.9979	0.9918
44.36	0.18	56.21	209.66	33.98	26.99	0.9968	0.9909
51.06	0.15	68.10	293.97	31.91	25.56	0.9951	0.9879

V. CROI WITH WAVELET ALGORITHM STEPS FOR COMPRESSION OF MEDICAL IMAGE FETUS.BMP

1) Step:- Initialize the image parameters and load the Image FETUS.bmp to be compressed selectively. Using function like IMREAD(). pre-processing is performed if required.



Fig 10. Fetus.bmp

2) Step: - Activation of the ROI mask we have to perform to get the selection of ROI.

3) Step:- ROI mask is activated, the priority adjustment is done to prioritize the encoding of Contextual region (ROI), so the ROI encoding can be done first and BG encoding can be done later

4) Step: - Now selection of the Contextual region i.e. the ROI is done based on the ROI mask. Using ROIPOLY() to select a polygonal region of interest within an image.



Fig 11. Activated Roi mass.bmp

5) Step:- The contextual region (ROI) is separated from the image as per the requirement and set high priority of encoding. Using IMMULTIPLY().



Fig 12. Separated Roi .bmp

6) Step:- Separate the BG form the image and assign low priority for encoding.

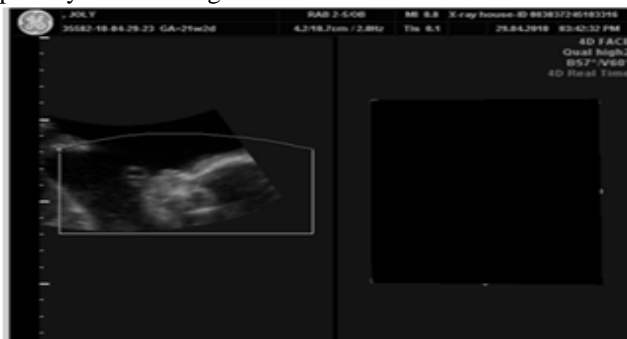


Fig 13. Separated Background.bmp

7) Step:-Select the compression methodology for CROI and BG respectively.

8) Step:- Calculate the wavelet coefficients of CROI & BG separately for priority encoding of the test image. Obtain the bit allocation for each CROI and BG regions.

Here we have used 'bio 6.8' wavelet up to Third level decomposition.

9) Step:-Quantize the wavelet coefficients for each subband of each region (CROI & BG) and send the quantized coefficients to entropy encoder progressively.

10) Step:-Compress the CROI region with very lower Compression Ratio (high bit rate) lossy or near lossless by quantization.

Compress the BG region with very high Compression Ration (low bpp) and lossy by quantization

11) Step:- Get the compressed bit stream of test image for CROI & BG separately

12) Step:-Merge the CROI and the BG regions to get decoded image

13)Step:-Calculate performance parameters of CROI,BG & Image. Check the Image quality by the HVS and the Correlation.



Fig 14.Result.jpg

VI. PERFORMANCE MESURING PARAMETERS CROI WAVELET

TABLE II
ROI and
ENTIRE IMAGE Parameters: CR,MSE,PSNR & CoC

CROI WAVELET PERFORMANCE MESURING PARAMETERS FOR US MEDICAL IMAGE FETUS							
CR	bpp	MSE		PSNR, dB		CoC	
		ROI	Entire Image	ROI	Entire Image	ROI	Entire Image
20.01	0.40	21.08	79.57	39.82	33.18	0.9991	0.9976
32.01	0.25	38.07	97.06	37.49	31.79	0.9988	0.9957
40.02	0.20	44.79	128.88	36.49	29.59	0.9986	0.9938
44.36	0.18	55.49	129.89	34.02	27.98	0.9978	0.9935
51.06	0.15	67.84	133.99	32.51	25.58	0.9969	0.9927

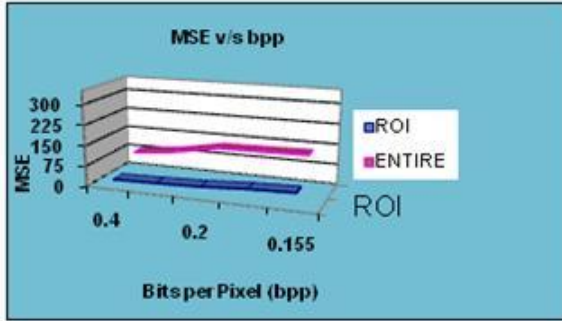


Fig.15. Graphical Representation: Bpp Vs MSE

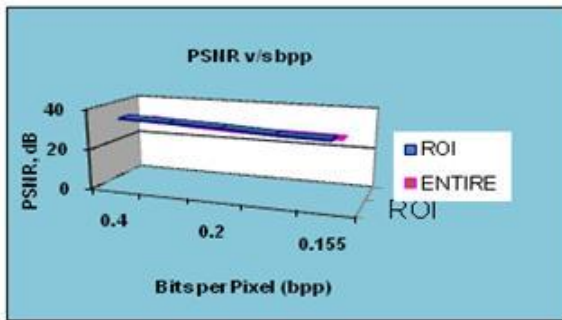


Fig 16. Graphical Representation: Bpp Vs PSNR

VII. COMPARATIVE ANALYSIS OF CROI JPEG & WAVELET

TABLE III
PSNR Comparison of JPEG & WAVELET

Sr.No	CR	PSNR(dB)	
		JPEG	WAVELET
1	20.01	38.22	39.82
2	32.01	37.39	37.49
3	40.02	35.44	36.49
4	44.36	33.98	34.02
5	51.06	31.91	32.51

TABLE IV
MSE Comparison of JPEG & WAVELET

Sr.No	CR	MSE	
		JPEG	WAVELET
1	20.01	21.98	21.08
2	32.01	39.10	38.07

3	40.02	45.13	44.79
4	44.36	56.21	55.49
5	51.06	68.10	67.84

TABLE V
CoC Comparison of JPEG & WAVELET

Sr.No	CR	CoC	
		JPEG	WAVELET
1	20.01	0.9989	0.9991
2	32.01	0.9983	0.9988
3	40.02	0.9979	0.9986
4	44.36	0.9968	0.9978
5	51.06	0.9951	0.9969

VIII. RESULTS AND DISCUSSION

Using conventional compression we get maximum CR up to 40 for Medical Images but using CROI with JPEG & WAVELET method we get entire CR up to 65 with good visual quality of ROI. CROI method with WAVELET based compression algorithm gives higher PSNR less MSE and nearer CoC than JPEG. ROI is compressed with better quality than background for so .we get the good visual quality of image area (ROI).

IX. CONCLUSION & FUTURE WORK

WAVELET with CROI is a powerful tool for compressing an image than JPEG. We can also implement CROI method with other compression algorithms using automatic separation of ROI.

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Authors Profile

I am Prof. Sejal Thakkar I am having 12 years of teaching experience from reputed colleges. I have published more than 11 papers in reputed journals and conferences including IEEE Scopus and Thomson Router indexed journals my area of research is at Image processing, pattern recognition and image compression side.

