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Medical Image Compression using Block Processing with DCT

Himani[1], Pawan Kumar Mishra[2]

M.Tech Scholar, Department of Computer Science & Engineering, Uttarakhand Technical University, Dehradun, India[1]

Assistant Professor, Department of Computer Science & Engineering, Uttarakhand Technical University, Dehradun, India [2]

Abstract: To provide an efficient image compression method for medical imaging , an effective approach Discrete Cosine Transform (DCT) with block processing is presented in this paper. To stimulate image transformation, discrete cosine transformation is used first. The discrete cosine transformation transform image into several parts by keeping image visual quality. DCT is most commonly used transformation based on fourier transformation. After successful transformation using DCT method block processing is applied on transformed image. In block processing operations are performed on blocks of image instead processing whole image. In our proposed paper block processing on image is done with 8X8 block. Experimental results shows that block processing with dct compress images faster compared with conventional DCT and older variant of other variant of DCT.

Keywords: Image Compression, Medical Imaging, PSNR, MSE, Compression Ratio (CR), Compression size, Block processing. CT, MRI, PET.

I. INTRODUCTION

Medical imaging is an application area of imaging which is used to generate images of the human body (or parts and function thereof) for medical or clinical purposes. Medical imaging is used for generate images of internal body part of human body. Medical image is an essential part of modern healthcare, it provides a large set of data that is used in research and treatment of diseases, it provides a wealth of information that is increasingly relied upon in the clinical management of patients and conduct planning.

Medical imaging data is collected from community and human resource with respect to time involved in these activities. Once acquired, such data is not removed lightly because it is needed for future research and for repetition of test, these things will be minimize risk of research data and maximize productivity. Advances in technology have created the opportunity for radiology systems to use complex. Compression algorithms to reduce the file size of each image in an effort to partially offset the increase in data volume created by new or more complex modalities.

In field of medical imaging many types of images are used, some type are CT, MRI, and the combination of positron emission CT and CT (PET-CT), these all are becoming standard in health care industry. All treatments of a patient is totally depended in these images. Format of Medical images is Digital Imaging and Communications in Medicine (DICOM) format. Defiantly DICOM is a non-compressed raw format. The large amount of data creates demand for compression for storage and data transmission purpose.

Image compression is a process of data compression and it is used for reducing redundancies in image. Compression is divided in Lossy and Lossless.

Lossless techniques, gives a correct reconstruction of the original image, whereas lossy techniques achieve higher compression ratios by allowing some acceptable degradation. The selection of method is depend on application area. In general, for medical imaging, we cannot afford the loss of information and hence lossless compression is preferred. For telemedicine transmission, to exploit greater data compression and hence faster transmission speed, lossy compression is acceptable as long as the required diagnostic data is preserved. This paper introduced a lossless image compression algorithm for possible telemedicine transmission use.

JPEG image compression is based on DCT. Among compression techniques the discrete cosine transformation is a fast transformation. It is powerful technique for image compression and widely used for compression.

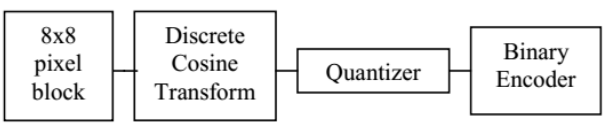

Figure 1 Block Diagram of DCT Compression

For the compression of medical images, the DCT algorithm has achieved good performance and many variants have been developed to for different purpose. Yen-YuChen et al. [1] used DCT-based subband decomposition and modified

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SPIHT data organization for medical image compression. Yung-Gi Wu et al.[2] Medical image compression by sampling DCT coefficients. Manisha Gaonkar and Anuja P Parameswaran [3] proposed Medical image compression by sampling DCT coefficients. V. Naga Prudhvi Raj et al. [4] A Novel Approach to Medical Image Compression Using Sequential 3D DCT. Singh S1, Kumar V, Verma HK. [5]proposed a DWT-DCT hybrid scheme for medical image compression.Marian Kazubek, Artur Przelaskowski, Tomasz Jamrógiewicz et al. [6] proposed an application of Medical Image Data Characteristics for constructing DCT-based compression algorithm.

II. RELATED WORK

Andrew B. Watson [7] NASA Ames Research Center has proposed DCT technique for converting a signal into elementary frequency components. It is widely used in image compression and develops some simple functions to compute the DCT and to compress image. These functions illustrate the power of Mathematic in the prototyping of image processing algorithms.

Prachi Natub, H. B. Kekrea, and Tanuja Sarode [8] proposed color image compression using vector quantization and hybrid wavelet transform. Many image compression technologies are being developed. Wavelet transformation is used for image compression. After advancement in this compression technique hybrid wavelet transformation was introduced. Compression result was very good of hybrid wavelet compare to other compression. Wavelet transformation with vector quantization is applied to increase compression ratio.

Prabhpreet Kaur, Navpreet Saroya[9] presents Discrete Cosine Transform (DCT) and Discrete Wavelet transform (DWT) implementation because these are lossy techniques.

Archana Deshlahra, G. S. Shirnevar [10] proposed comparative study of 3 transform techniques, which are Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) & Hybrid (DCT+DWT) Transform.

Khan Wahid and Suchitra Shrestha [11] proposed a hybrid algorithm that performs a Discrete Cosine Transform (DWT) on Discrete Wavelet Transform coefficients. In this paper, presented algorithm gives good result much better in term of peak-signal-to-noise-ratio with a higher compression ratio to standalone DCT and DWT algorithms.

Dr. K. Kuppusamy, D. Malarvizhi, [12] introduced a new technique for simultaneous image acquisition and compression called adaptive compressed sampling. It creates demand for image reconstruction on compressed images. Reconstruction is a challenging work after decompression of image, because loss in quality and data makes no use of image after compression.

III. PROPOSED METHODOLOGY

An image compression process for medical images is generally defines a specific set of images which are containing sensitive information of human being, loss of information from these images means that no use of images. After image compression, compressed image is compared with original image. For comparing two images several parameters are required such as compression ratio, PSNR, MSE and compressed size.

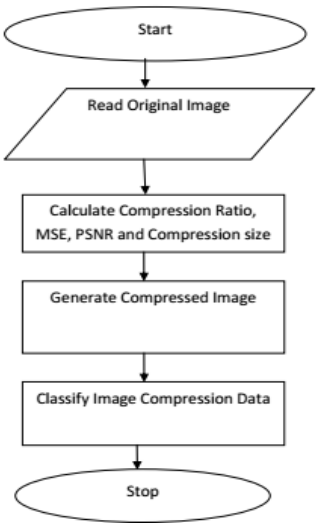

Figure 2 Architecture of proposed methodology

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The details about the steps adopted in the methodology are described in the following subsections.
DCT compression occurs in following steps as:
The image is subdivided into small blocks. If the total size of the image is N x N then each of the blocks has the size of (N/n) X (N/n). Mostly we use N/n=8. The main purpose of having such non overlapping blocks is that we can perform parallel processing on each of the blocks. We are able to find correlation existing in the same block and can exploit more redundancy in much better way.
In our approach first original image is loaded in the system which is main thing of whole process. Image can be in any extension. After loading of image original image size will be display on user window, by checking this size user can check image size. In second step user start compression process by pressing compress image button. This process will take few seconds to load compress image and perform required calculation. Basically in case of image compression PSNR, MSE, compressed size, compression ratios are calculated.

PROPOSED ALGORITHM

Proposed Algorithm for Medical Image Compression Setup

Initialize required variables
Create Forms to Collect Data
Start
Step1. R← read original image
Step2. R← get red channel
Step3. T←Generate 8X8 discrete cosine transform Matrix
Step4. B←Perform 8X8 block processing over R using Matrix generated in step 3
Step5. mask ← create a mask

```
[1  1  1  1  0  0  0  0
     1  1  1  0  0  0  0  0
     1  1  0  0  0  0  0  0
     1  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]
```

Step6. B2 ← block process over B using mask
Step7. I2 ← block process over B2 using T, and inverse of T
Step8. Repeat steps 3 through 6 for Green and Blue channel

STEP9. L ← CONCATENATE R, G AND B TO GET A COMPRESSED IMAGE

IV. PERFORMANCE

Compression Ratio

Compression ratio is defined as ratio between original size and compressed size. If x_1 and x_2 represents the number of information- carrying units in two sets that represents the same information, the relative data redundancy R_D of the first data set can be defined as

$$R_{D=} 1- 1/C_R$$

Where C_R, is commonly called the compression ratio.

$$C_R = x_{1/} x_2$$

MSE

The MSE is a measure of the quality of an estimator—it is always non-negative, and values closer to zero are better. MSE is defined as following:-

$$\frac{1}{MN} \sum_{y=1}^{M} \sum_{x=1}^{N} [I(x,y) - I'(x,y)]^2$$

In this equation compressed version and original version of image is used for calculation. I(x,y) is the original image, and I'(x,y) is the approximated version and M,N are the dimensions of the images. A lower value for MSE means less error.

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PSNR

It is designed to measure the difference in pixels value between of two images. PSNR is calculated via the mean squared error (MSE). PSNR can be defined as:-

PSNR = $20 * \log_{10} (255 / \sqrt{(\mathbf{MSE})})$

Logically, a higher value of PSNR is good because it means that the ratio of Signal to Noise is higher. Signal is used for original image and noise is used for error in reconstruction. So, if compression scheme having a lower MSE (and a high PSNR), you can recognise that it is a better one.

V. RESULT AND DISCUSSIONS

In the proposed work, medical image are compressed using block processing with DCT method. DCT is popular method for image compression because of its performance. In our work first images are transformed using DCT and then block processing is used on transformed image. After image compression is done first MSE of image is calculated because it is needed in calculation of PSNR. Based on these two parameters compression ratio is calculated between original image and compressed image.

The algorithms are implemented on MATLAB 2016a version.

SYSTEM IMAGE

Proposed System Image compression

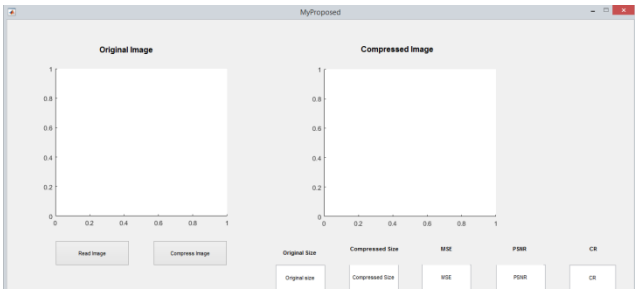

Figure 3 Proposed Paper Image Compression Window

To load an image in system user has to click on read image button. After clicking on this button following window will appear where user has to select image for compression.

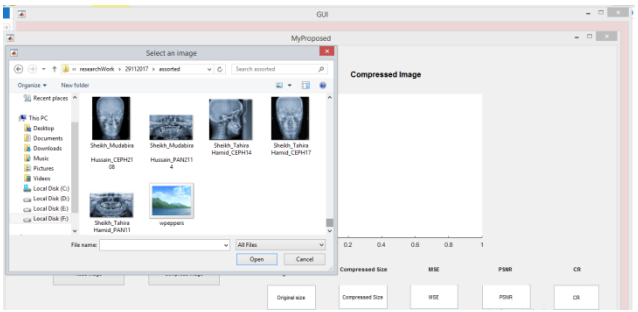

Figure 4 Reading an Image Window

After loading an image user will able to see image for compression in below figure 5.

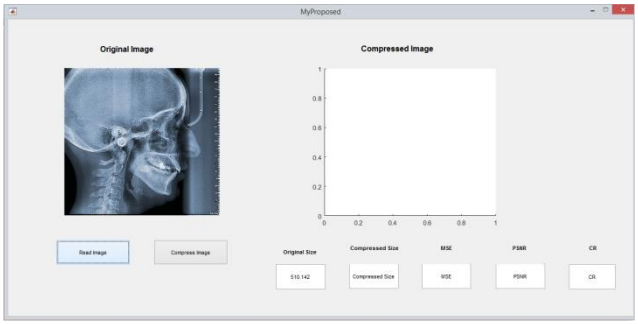

Figure 5 Original Image Loaded Window

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After image loading user has to click on compress image button to get compressed image, after this step user will get result of compression which is shown in next figure.

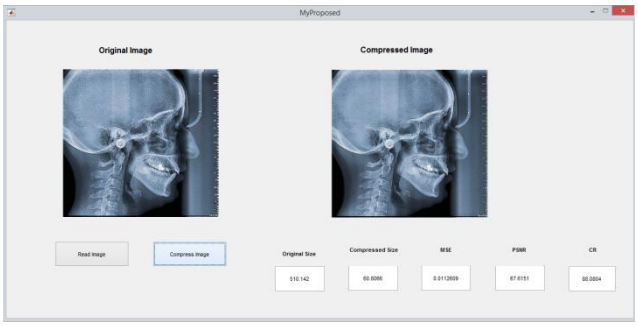

Figure 6 Proposed Paper Result Window

In above figure 6, two images are loaded in system, Image first (right side) is original image and second image (left side) is compressed image. All Calculation result for MSE, PSNR and compression ratio are below.

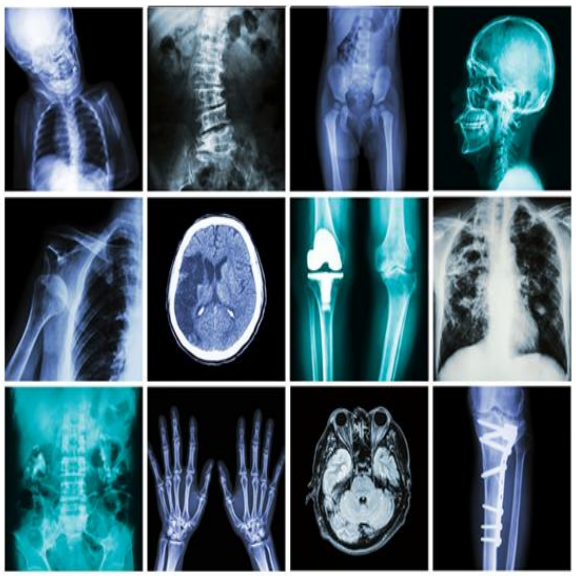

Figure 7 Medical Image sequence

Table 1 Comparison of PSNR is following:

Sr.	3DSPIHT COMPRESSION SIZE	BLOCK PROCESSING WITH DCT COMPRESSION SIZE
1	80.5592	50.5206
2	78.0232	40.4854
3	52.1846	34.2314
4	91.418	58.29
5	78.8301	43
6	50.4844	33.3076
7	73.7559	51.541
8	61.002	38.7031
9	58.5225	40.1357
10	83.374	55.7227
11	69.1318	40.7979
12	61.887	41.6855
13	77.002	51.6797
14	60.5615	37.791

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15	62.0898	40.9746
16	105.775	60.8066
17	83.334	43.2383

Table 2 Comparison of image size is following:

Sr.	3DSPIHT MSE	BLOCK PROCESSING WITH DCT MSE
1	0.052296	0.0123321
2	0.0581552	0.00961908
3	0.0527614	0.0113714
4	0.0852592	0.0116339
5	0.0932309	0.00847277
6	0.0516024	0.0106825
7	0.0502525	0.0111207
8	0.0541364	0.00931134
9	0.0515927	0.0119299
10	0.0646349	0.0124505
11	0.0725783	0.00930575
12	0.0621307	0.0116474
13	0.0546344	0.0116975
14	0.0556946	0.0086066
15	0.0652244	0.0110861
16	0.14161	0.0112609
17	0.112097	0.0095756

Table 3 Comparison of MSE is following:

Sr.	3DSPIHT PSNR	BLOCK PROCESSING WITH DCT PSNR
1	61.2204	67.2204
2	62.2995	68.2995
3	61.5727	67.5727
4	61.4636	67.4636
5	62.8505	68.8505
6	61.8441	67.8441
7	61.6695	67.6695
8	62.4407	68.4407
9	61.3644	67.3644
10	61.1789	67.1789
11	62.4433	68.4433
12	61.4685	67.4685
13	61.4499	67.4499
14	62.7825	68.7825
15	61.683	67.683
16	61.6151	67.6151
17	62.3191	68.3191

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Table 4 Comparison of Compression ratio is following:

Sr.	3DSPIHT Compression Ratio	BLOCK PROCESSING WITH DCT Compression Ratio
1	80.5592	86.9107
2	78.0232	86.0056
3	77.5093	85.2468
4	80.827	87.7749
5	75.3379	86.5474
6	77.5774	85.2064
7	80.7119	86.5214
8	77.9232	85.9932
9	78.54	85.2824
10	81.1933	87.4306
11	76.7153	86.2587
12	80.1363	86.6207
13	80.599	86.9791
14	77.2328	85.7931
15	78.292	85.6744
16	79.2655	88.0804
17	74.4633	86.7501

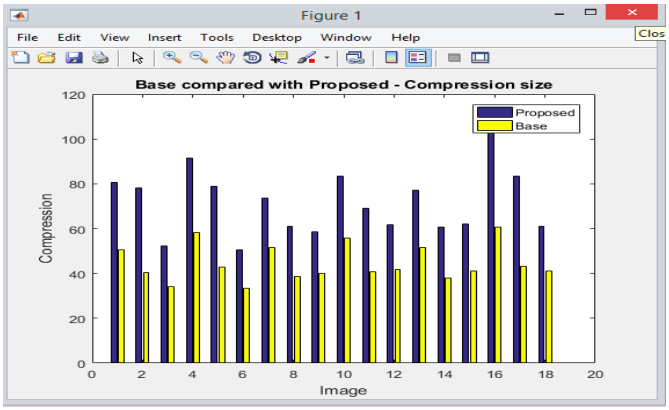

Figure 8 Compression size comparison

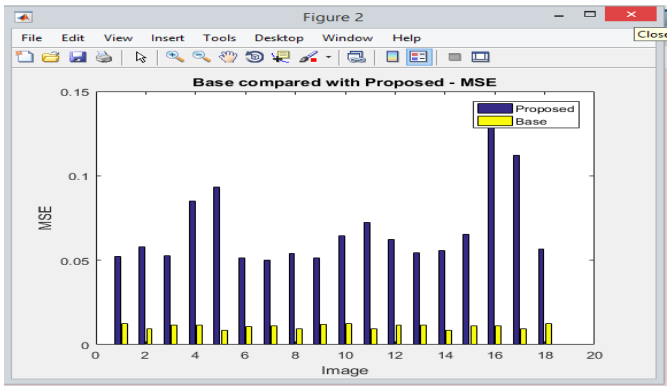

Figure 9 MSE comparison

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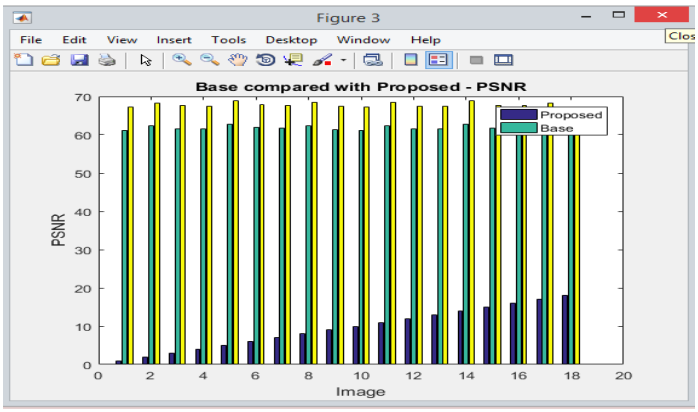

Figure 10 PSNR comparison

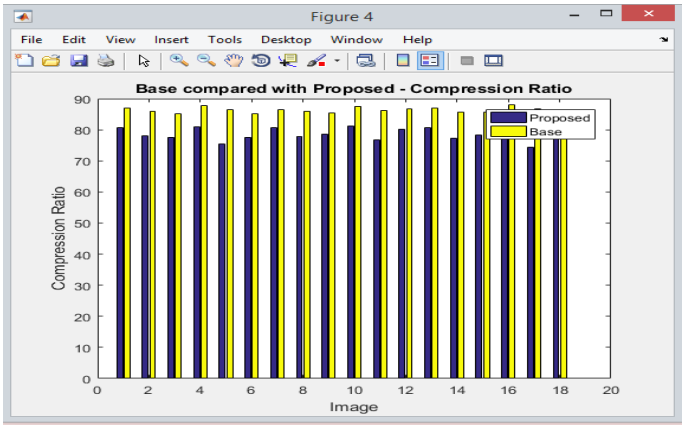

Figure 11 Compression Ratio comparison

CONCLUSION AND FUTURE SCOPE

In this paper, a fast algorithm based on block processing with DCT is proposed for 3D medical image compression. This work has been done on real medical images, where lossless compression is needed. In medical science lossless compression is preferred because loss of data can make diagnosis result incorrect and doctor can feel difficulty during treatment. The proposed algorithm significantly reduced the compression size, maximize the peak signal noise ratio 6%, and improve compression ratio and MSE. Our proposed algorithm is general and it will be applied to any kind of high resolution images (in field of medical science for e.g. MRI, CT scan) in our future work.

The field of medical image compression is ripe for explosive growth. In future work, the study can be enhanced by combining others technique with our proposed algorithm. Also, the work can be carried out with other modern techniques to get better result.

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BIOGRAPHIES

Ms. Himani completed Bachelor of Technology in computer science from Uttarakhand technical university Dehradun in 2015 and she is currently pursuing Master of technology under Uttarakhand technical university Dehradun, India.

Mr Pawan Kumar Mishra is working as an Assistant Professor and Head of the Department, Computer Science and Engineering, Faculty of Technology, Uttarakhand Technical University, Dehradun, India.