International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 04 | Apr -2017 www.irjet.net p-ISSN: 2395-0072

Lossless Optimal Compression of Medical Data Using Adaptive Golomb Rice Encoding

Sailendra Kumar Verma[1], Sandeep Kumar[2], Pranav Tripathi[3]

[1,2,3]UG Scholar
Department of CSE, GCET, Gr. Noida, Uttar Pradesh, India

Abstract - *Image compression is a widely used to reduces the storage and communication overhead during the transmission of the files but there is always risk of information loss in this process. Lossless compression is an approach to achieve the significant compression ratio without losing any information about the file. Which encourages the Remote Medical Monitoring system, it is an application of telemedicine, in which we provide the digital medical support easily to the disaster areas using compressed data transmission. Compression is the process of reducing the elements of the data which does not affect the necessary properties of the data. In this paper we are proposing the modifications in the lossy techniques to achieve the lossless compression. The technique uses the blocks of optimal size to prevent data lose with lower increment in computation. IntDCT is used to get frequency information and to perform quantization. Modified Golomb-Rice code are used for further encoding the coefficients of the data.*

Key Words : Lossless Image Compression, Golomb-Rice Code, Discrete Cosine Transform, Quantization, Color-space Conversion.

1. INTRODUCTION

Image Compression can be used as an efficient approach in Remote medical monitoring (RMM) system based primary health care (PHC) system which is an application of the telemedicine. PHC provides the fast medical support in disaster areas where physical medical support cannot be easily provided. PHC optimally compresses the large medical data of patients and send it to the care centres. Doctors at the care centres , will analyze and send correct prescription back to the PHC through the fast transmission medias like WANET.

We can perform lossless compression of the data in the text format .In this paper we proposed the technique to perform the lossless compression of the data which is in the image format. Various techniques are present which can perform the lossless compression of images but sometimes in medical process we cannot afford the loss of information in the medical data of patients. In the proposed technique we will first get the luminance and chrominance attributes of the image separately to do so we are performing color-space conversion of the image from RGB to YC_bC_r. Because human eyes are more sensitive to the luminance factor so we can perform the down sampling of the chrominance attributes.

After this we take matrix of 4 × 4 and perform all the operations on these blocks of the image. First we use IntDCT to convert the images in to frequency domains in this process we use a standard matrix to find the pixels frequency values. Next, we perform quantization the real compression is performed here because most of the less effectives coefficients become zero in this process. We separate both AC and DC coefficients and use zig - zag and differential encoding respectively further these coefficients are encoded using the modified Golomb-Rice codes. The reverse process is performed at the receiver ends to get the information from the compressed data to get the actual data. The complete procedure followed for compression is shown in Figure 1.

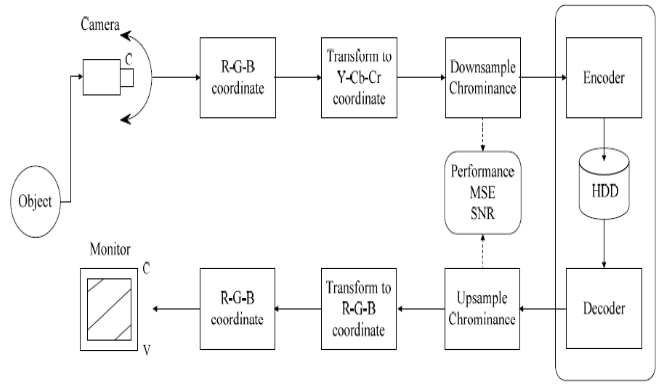

Fig - 1: Image Compression Process

2. Proposed Medical Data Compression Technique

JPEG (Joint Photographic Experts Group) compression is the most popular compression technique for images. In lossy JPEG compression, pixels are first transformed using discrete cosine transform (DCT), then quantized using quantization tables, and finally encoded using Huffman coding. In the proposed technique we perform modification in size of block element and use the Golomb-Rice codes for encoding to get the lossless compression.

2.1 Color-space Conversion

Generally the input images are in RGB format which uses mixing of color displays. In image processing processes like compression we require the detailed information of the image in terms of its luminance and chrominance factors. We convert the RGB image in to more detailed color-spaces. YC_bC_r is mostly used color space in image processing where Y is the luminance factor and C_b C_r are the chrominance factors of the light . To enable more efficient processing and transmission of color signals it is desirable to describe a color in terms of its luminance and chrominance content separately. Our human eyes are more sensitive to the luminance attributes than the chrominance attributes of light, because chrominance components sampling rate is half that of the luminance component. We can down sample the chrominance factors of the image and it will not affect the visual quality of the image.

2.2 Block wise pixel scanning

The detailed characteristics of the image will be omitted after quantization due to the high computational burden for implementing full-image transformation. The image is therefore divided into non-overlapping blocks to decrease the number of operations. The conversion of progressive pixel scan to block-wise order is required to operate on small non-overlapping image blocks. The advantages of small block size are less computational complexity and moderate memory requirement, but the size of compressed data is large. On the other hand, large block size can attain significantly compressed data for the consequent coefficients of small magnitude but may cause visual distortions. However, to avoid visual artefacts [4] in the case of higher compression of MDPs, the size of the transformed block was set to 4 × 4. The MDC technique therefore operates on non-overlapping 4 × 4 .

2.3 Decor-relation and Quantization

The reason Why an image can be compressed is that the correlation between one pixel and its neighbor pixels is very high, or we can say that the values of one pixel and its adjacent pixels are very similar. In this technique we use intDCT to reduce the correlation. The discrete Fourier transform (DFT) is act like as mathematical prism . Which converts a complex signal into its spectrum. In most of the real signals the half of the data is redundant . In frequency domain, the real part of the spectrum is even symmetric and imaginary part odd time domain, while in the time domain the imaginary part of the signal is all zero;. Discrete cosine transform (DCT) transforms is a real transform that avoids the problem of redundancy by transforming a sequence of real data points into its real spectrum .Although Karhunen-Love transform (KLT) which is the signal dependent, is the most efficient transform of de-correlating pixels for compressing the component planes to a single spectral plane of a colour image prior to encoding using the maximum energy compaction. But because it depends on signal statistics and does not have an efficient implementation , the KLT transform is not used in practice.

Quantization is the step where we actually throw away data. The DCT is a lossless procedure. In the Quantization process every coefficients in the 4×4 DCT matrix is divided by a corresponding quantization value. The main aim of quantization process is to reduce most of the DCT coefficients to zero which are less important high frequency, the greater number of zeros we generate the better the image will compress. The matrix Q generally has lower numbers in the upper left direction, which is the DC coefficient and large numbers in the lower right direction which are the AC coefficients. Though the high-frequency components are removed, still we can obtain an approximate matrix which is as close to the original 4×4 block matrix. Integration of quantization with the transformation process used to avoid the extra multiplications in the transform process and use of Block wise access decreases rounding operation and decreases the computational overhead.

The coefficients obtained from the block transformation will be entropy encoded using an efficient encoder, which is presented in the next section.

2.4 Encoding of coefficients

A hardware efficient encoder is used to encode the transformed coefficients. The coefficients of a block are partitioned into DC and AC coefficients. First, DC coefficients which are at left most upper corner, are differentially encoded. The DC coefficients possesses most of the properties of the image so these can be treated as an image that has the same properties as in real images but in smaller size. Now we can efficiently encode this smaller image using JPEG-LS with adaptive coding that reduces the number of passes and one pass through the data will be enough. After differentially encoding, the DC coefficients we use Adaptive Golomb Rice codes for further encoding the coefficients. The AGR encoder encodes the coefficients as in eqn 1 by using some prefixes and suffixes :

$$G(u,k) = \underbrace{(11...1)}_{\text{Prefixes,p bits}}\ 0\ \underbrace{(b_{k-1}\,b_{k-2}\,...b_0)}_{\text{Suffixes,k bits}} \quad (1)$$

The AGR encoder encodes any positive integer u as two strings: a prefix of $p + 1$ bits and a suffix of k bits, where k is the parameter that is already given and $p = u/2k$. For example, if $u = 20$ and $k = 3$, then the code for u is ‘11011’, the prefix is ‘11’ and the suffix is ‘11’.We need an additional mapping function to transform DC coefficients to non-negative integers because the AGR encoder only encodes non-negative integers using the mapping function given in eqn 2.

$$F1(d) = \begin{cases} 2d & \text{if}(d \geq 0) \\ 2|d| - 1 & \text{otherwise} \end{cases} \quad (2)$$

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 04 | Apr -2017 www.irjet.net p-ISSN: 2395-0072

Where d is the DC coefficient and $|d|$ absolute value that particular DC coefficient . The first block will be correctly, error-free decoded in to code words in forward as well as reverse directions by AGR encoder. Because of the energy compaction property of IntDCT in quantization process most of the AC coefficients with less effective high frequency are quantized to zero. All other remaining nonzero coefficients in a block are clustered around the DC coefficient because of the low frequencies.

Zigzag scanning process is used to scan the AC coefficients. The encoder used to encode AC coefficients uses zero run-length encoding principle. Since AC coefficients are signed values, so we need a mapping function as given in eqn 3 to convert a nonzero AC coefficient a to a positive integer for the AGR coding,, denoted by $F2(a)$.

$$F2(a) = \{F1(a) : a \in Z\_=0\} \quad (3)$$

Because of the less efficiency of the Golomb - Rice codes with adjustable k in encoding low entropy distributions, such as, encoding AC coefficients of image with zero value we modified the GR coding scheme. In Adaptive GR code, the encoded sequence is therefore rearranged in such a way so that it form (r, q) pairs, where r *is* a nonzero AC coefficient which is followed by q numbers of consecutive AC coefficients with zero-value. Any AC coefficient with zero-value in a block is represented by a single symbol $(0, 0)$. Because most of the AC coefficients values became zero in quantization, symbol $(0, 0)$ occurs very frequently, For maximizing the compression efficiency we assigned symbol $(0, 0)$ the value '0' .

3. Performance Evaluation

In this section we evaluate the performance of the proposed technique and will compare with the other techniques of image compression. We performed the compression on a large no of endoscopic image with various resolutions and sizes. The proposed technique compresses the images with significant compression ratio while maintaining the quality of the image. The complete process of the proposed approach for compression is shown in Figure 2 and for decompression in Figure 3.

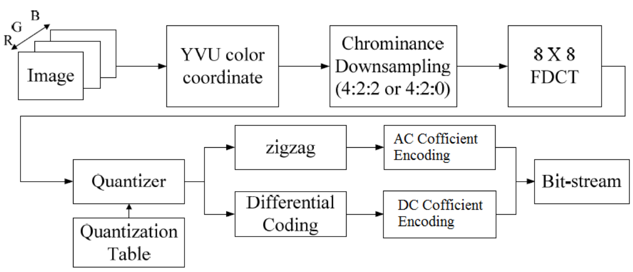

Fig -2 : Compression process using AGR Encoding

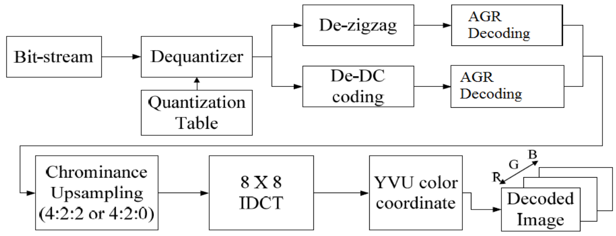

Fig - 3: Decompression process Using AGR Decoding

We can also compress the other type of medical images *e.g.* electrocardiography images, magnetic resonance imaging, etc. The histograms of original and decompressed images are almost similar with high probability. Peak Signal-to-Noise Ratio (PSNR) is used to evaluate the quality of image reconstruction which can be obtained using the eqn 4.

$$PSNR\ (dB) = 10\ \log\ (255 / (a_i - \bar{a_i})^2) \quad (4)$$

Where a_i and $\bar{a_i}$ are values of a pixel in original and decompressed images.

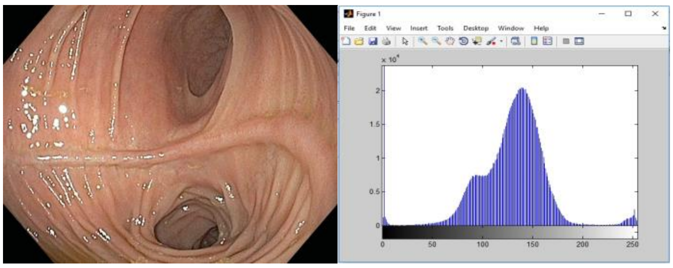

Fig - 4: Input Endoscopic image

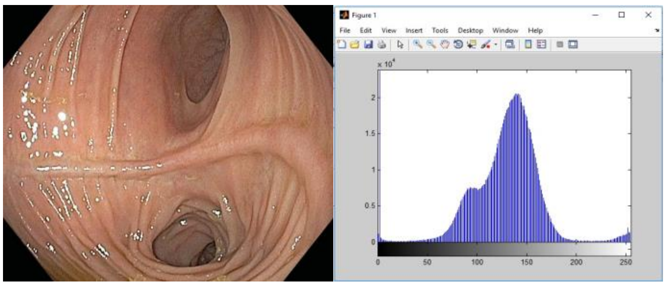

Fig - 5: Compressed Endoscopic image

The proposed approach was implemented on a system with 4 GB RAM and intel core i5. The results obtained are shown in Figures 4 and 5. It is observable that the visual quality histogram of the compressed image is same as the original image, thus demonstrating lossless compression. The larger the size of the image, better is the compression efficiency.

The average quality rating also known as Mean Opinion Score (MOS) is calculated over a number of human observers who have been asked to score an image, often on the scale from 1 (worst) to 5 (best) .Compression Ratio (CR) is the ratio of the size of an original image to the size of its compressed counterpart. As the CR increases, the bit rate will decrease to achieve highly compressed data. However, visual artefacts may occur when CR is very high in case of lossy compression techniques. While in the proposed technique we can compress the image up to large compression ratio according to property of the image.

4. CONCLUSION

This paper proposes a technique to enhance the Remote Medical Monitoring system in India. Using this approach we can compress the large medical data of the patients and can easily transmit it over the fast network to the care centre so that the better support can be provided to the people in disaster areas.

The graph shown in Figure 6 represents that the compression ratio calculated for the proposed approach is higher than other conventional techniques in this field like JPEG compression, Tureza and Duplaga technique etc.

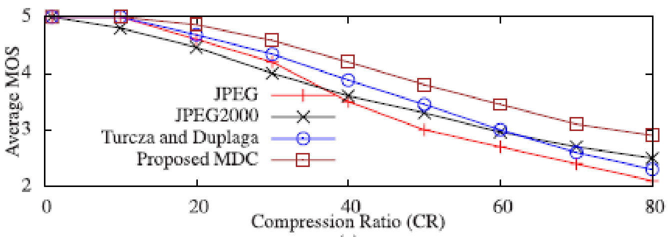

Fig – 6 : Comparative analysis of various Compression Techniques

The proposed technique can optimally compress the medical data of patients based on the type of information and what minimum quality of the data should be preserved to be acceptable.

ACKNOWLEDGEMENT

This research was supported and encouraged by Santosh Kumar Upadhyay, Asst. Professor, Department of CSE, GCET, Greater Noida, Uttar Pradesh, India. We also thank Manish Kumar Sharma, Asst. Professor, Department of CSE, GCET, Greater Noida, Uttar Pradesh, India for enlightening us throughout the research work.

REFERENCES

[1] J. Wagh," Medical Data of Patients Management Using Wireless Ad-hoc Network-WANET ",Vol.6 – No.4, April 2016.

[2] Basila L. D. ,"An Efficient Remote Medical Monitoring Systen in WANET using Data Compression & Fuzzy Logic Route Selection ",Vol. 3 – No. 10, March 2016.

[3] Mohd. Rababah,"Implementation of Novel Medical Image Compression Using Artificial Intelligence", International Journal of Computer Science and Applications, Vol. 7 – No. 5, pp. 328 – 332, 2016.

[4] Tanima Dutta," Medical Data Compression and Transmission in Wireless Ad Hoc Networks", IEEE Sensors.Journal, Vol. 15, No. 2, Februray 2015.

[5] A. Bruna," Principles of Image Compression ", Advanced System Technology, Catania, 2008.

[6] Wei-Yi We," An Introduction to the Image Compression ", Master's Thesis, National Taiwan University, Taipei, 2008.

[7] A. Kiely," Selecting the Golomb Parameter in Rice Coding ",IPN Progress Report, pp. 42-159, November 2004.

[8] K. Cabeen and P. Gent," Image Compression and the Discrete Cosine Transformation ", College of the Redwood.

[9] N. Memon," Adaptive coding of DCT coefficients using Golom-Rice Codes"

[10] MatLab Available : http://www.mathworks.in/,accessed 2017.

[11] JPEG. [Online]. Available: //http://www.jpeg.org/, accessed 2017.

[12] JPEG2000.[Online]. Available: http://www.jpeg.org/, accessed 2017.