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Medical Image Compression Using DCT and SPIHT Algorithm

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Abstract:- **Image compression techniques, especially non-reversible or lossy ones, have been known to grow computationally more complex as they grow more efficient, confirming the tenets of source coding theorems in information theory that a code for a (stationary) source approaches optimality in the limit of infinite computation (source length). Discrete Cosine Transform approach is adopted to perform sub band decomposition. Modified set partitioning in hierarchical trees (SPIHT) is then employed to organize data and entropy coding. The translation function can store the detailed characteristics of an image. A simple transformation to obtain DCT spectrum data in a single frequency domain decomposes the original signal into various frequency domains that can further compressed by wavelet-based algorithm. In this scheme, insignificant DCT coefficients that correspond to a particular spatial location in the high-frequency sub bands can be employed to reduce redundancy by applying a proposed combined function in association with the modified SPIHT.**

Keywords – EZW, SPIHT, SOT, SP, RP

I. INTRODUCTION

In recent, the wavelet-based image encoding algorithms considerably improve the compression rate and the visual quality, therefore many researches proposes many different methods for encoding the wavelet based images. The SPIHT algorithm is an efficient method for lossy and lossless coding of natural images. The SPIHT algorithm adopts a hierarchical quad-tree data structure on wavelet-transformed image. The energy of a wavelet-transformed image is concentrated on the low frequency coefficients. A tree structure, called spatial orientation tree (SOT), naturally defines the spatial relationship of the hierarchical pyramid. The coefficients are ordered in hierarchies. According to this relationship, the SPIHT algorithm saves many bits that specify insignificant coefficients.

The Set Partitioning in Hierarchical Trees (SPIHT) algorithm is a generalization of EZW algorithm. The EZW transmits a lot of information for little cost when we declare the entire sub tree to be insignificant. The SPIHT algorithm uses a partitioning of the trees called Spatial Orientation Trees (SOT) in a manner that tends to keep insignificant coefficients together in large subsets. The partitioning decisions are binary that are transmitted to the decoder, providing a significance map encoding that is more efficient than EZW. The efficiency of significance map encoding in SPIHT is such that arithmetic coding of the binary decisions provides very little gain. The thresholds used to check significance are powers of two, so in essence the SPIHT algorithm sends the binary representation of the integer value of the wavelet / DCT coefficients. As in EZW, the significance map encoding, or set partitioning and ordering step, is followed by a refinement step in which representations of the significant coefficients are refined. After the wavelet transform, we use the SPIHT algorithm to encode the wavelet coefficients. The SPIHT algorithm has received widespread recognition for its notable success in image coding. The principles of the SPIHT algorithm are partial ordering of the transform coefficients by magnitude with a set partitioning sorting algorithm, ordered bit plane transmission and exploitation of self-similarity across different layers. By following these principles, the encoder always transmits the most significant bit to the decoder [5].

II. SPATIAL ORIENTATION TREES

The sets in SPIHT are created and partitioned using a special data structure called a spatial orientation tree. This structure is defined in a way that exploits the spatial relationships between the wavelet coefficients in the different layers of the sub band pyramid. The sub bands in each level of the pyramid exhibit spatial similarity. Any special features, such as a straight edge or a uniform region are visible in all the levels at the same location.

<table>
<tr><td>LLLL</td><td>LLHL</td><td>HLLL</td><td>HLHL</td></tr>
<tr><td>LLLH</td><td>LLHH</td><td>HLLH</td><td>HLHH</td></tr>
<tr><td colspan="2">LH</td><td colspan="2">HH</td></tr>
</table>

SPATIAL ORIENTATION TREES IN SPIHT

Each level is divided into four sub bands. In each group, each of the four coefficients (except the top left one) becomes the root of a spatial orientation tree. The arrows show how the various levels of these trees are related. In general, a coefficient at location (i, j) in the image is the parent of the four coefficients at locations (2i, 2j), (2i+1, 2j), (2i, 2j+1), and (2i+1, 2j+1).

We use the terms offspring for the four children of a node, and descendants for the children, grand children and all their descendants.

III. SET PARTITIONING SORTING ALGORITHM

The actual algorithm used by SPIHT is based on the realization that there is really no need to sort all the coefficients. Instead of sorting the coefficients, SPIHT uses the fact that sorting is done by comparing two elements at a time, and each comparison results in a simple yes/no result. Therefore, if both encoder and decoder use the same sorting algorithm, the encoder can simply send the decoder the sequence of yes/no results, and the decoder can use those to duplicate the operations of the encoder. The subset of sub band coefficients C_i in the subset T is said to be significant for bit depth 'n' if max $_{i\varepsilon(t)}$ {|C(i)|>= 2^n}, otherwise it is said to be insignificant. If the subset is insignificant, a 0 is sent to the decoder. If it is significant, a 1 is sent to the decoder and then the subset is further split according to the spatial orientation tree until all the significant sets are a single significant point. Since the result of each significance test becomes a single bit written on the compressed stream, the number of tests should be minimized. To achieve this goal, the sets should be created and partitioned such that sets expected to be significant will be large and sets expected to be insignificant will contain just one element. In this stage of coding, called the *sorting pass*, the indices of the coefficients are put onto three lists namely [5], [6].

LIS List of insignificant sets: contains sets of wavelet coefficients which are defined by tree structures, and which had been found to have magnitude smaller than a threshold (are insignificant).
LIP List of insignificant pixels: contains individual coefficients that have magnitude smaller than the threshold.
LSP List of significant pixels: pixels found to have magnitude larger that the threshold (are significant).
The definitions of the tree sets in the SPIHT are as follows:
O **(*i, j*)** in the tree structures, the set of offspring (direct descendants) of a tree node
Defined by pixel location (*i, j*).
D **(*i, j*)** set of descendants of node defined by pixel location (*i, j*).
***L*(*i, j*)** set defined by $L(i, j) = D(i, j) - O(i, j)$.

In this pass, only bits related to the LSP entries and binary outcomes of the magnitude tests are transmitted to the decoder. In implementation, we group together the entries in the LIP and LIS which have the same parent into an entry element. For each entry element in LIP, we estimated a pattern in both encoder and decoder to describe the significance status of each entry in the current sorting pass. If the result of the significance test of the entry item is the same as the specified pattern, we can use one bit to represent the status of the whole entry atom which otherwise had two entries and representation of significance by two bits. If the significance test result does not match the pattern, we transmitted the result of the significance test for each entry in the atom.

IV. Refinement Pass

After each sorting pass, we get the significant coefficients for the threshold 2^n, and then send to the decoder the *n*th most significant bit of every coefficient found significant at a higher threshold. By transmitting the bit stream in this ordered bit plane fashion, we always transmit the most valuable (significant) remaining bits to the decoder. The outline of the full coding algorithm is as follows:[6].

1. ***Initialization*****:** set the threshold**.** set LIP to all root node coefficients. Set LIS to all trees (assign type D to them). Set LSP to an empty set.

2. ***Sorting pass*****:** check the significance of all coefficients in LIP. If significant, output a 1, output a sign bit, and move the coefficient to the LSP. If not significant, output a 0.Check the significance of all trees in LIS according to the type of tree. For a tree of type D, If it is significant, output 1 and code its children. move the coefficient to the LSP If a child is significant, output a 1, output a sign bit, Add it to the LSP If a child is insignificant, output 0 and add the child to the end of LIP If the Children have descendants, move the tree to the end of LIS as type L, otherwise remove it from LIS. If it is insignificant, output a 0.For a tree of type L: If it is significant, output 1, add each of the children to the end of LIS as an entry of type D and remove the parent tree from the LIS. If it is insignificant, output a 0.

3. Refinement pass: For each entry in the LSP, except those included in the last sorting pass, output the n^{th} bit of the entry.

4. Loop: Decrement the threshold and go to step 2 if needed.

V. Implementation Details

1. 1. The SPIHT algorithm is optimized for its use with wavelets. Since we deal with DCT there is a need to modify the transformed coefficients in order to make it compatible with SPIHT. In order to apply this coding scheme we rearrange the coefficients to take full advantage of the scheme.

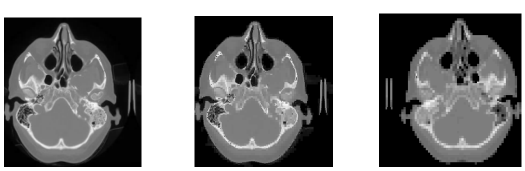
2. 2. We adopt a method in which we regard each sample in a 4x4 block as one frequency coefficient, and then collect the coefficients of the same frequency from all the blocks according to the block order. For transform coefficients matrix Tran [Mr] [Nc], the matrix of coefficients rearranged become W [Mr] [Nc]. There is a relation between them: **W[(i%4)Mr/4 + i/4] [(j%4)Nc/4 + j/4] = Tran[i][j]**

   where i=1,2,...,Mr, j=1,2,...,Nc, % denotes modulus operator. This rearranging method corresponds to the complete decomposition of wavelet coefficients. A complete decomposition is that all the four sub bands are decomposed into four more subbands as well. As a result, the sizes of all subbands are the same.
3. 3. The SPIHT we employ here is intended for thresholding and not coding purpose. Hence what we do is that we select all the coefficients above the value of threshold (**t**) and pass them and make all the coefficients below the threshold to zero.
4. The threshold (**t**), is obtained by: $\mathbf{t(u) = 2^{p-u}}$ Where u= 0, 1, 2, 3… p denotes the pass number and $\mathbf{p = \lfloor \log \max(c(i, j)) \rfloor}$

   Where c (i, j) is the coefficient at position (i, j) in the image.

5 Thus we are left only with the coefficients above the value of threshold. The entire procedure is repeated for different levels of threshold in search for a decent match of CR and PSNR. This is done with the following equation **if (abs (out[r+i][c+j])< X * t) (out[r+i][c+j])=0** where 'X' denotes the value of threshold to be set like 2t, 3t, 4t, 5t…etc.

VI. RESULTS



T = 0,Qp = 0   T = 5t,Qp = 20   T = 10t,Qp = 30
Cr=2.68, PSNR=39.7, Cr=7.53, PSNR=29.6 , Cr=29.64, R=21.82

CONCLUSION

The encoding and decoding are comprised of simple operations: comparison to threshold, movement of co-ordinates to lists, and bit manipulations. There are no complex calculations needed for modeling and training prior to coding. The only search is the single search for the initial threshold. The method is completely self-adaptive, always finding the most significant bits of the largest coefficients and sending them before those bits of smaller coefficients. The method is also extremely efficient; as it has the capability to locate large descendent sets with maximum magnitude smaller the final threshold and representing them with a single 0.

FUTURE SCOPE

For achieving higher compression rates SPIHT for coding followed by CABAC may be employed. In order to remove the blocking artifacts in the images a deblocking filter may be employed.

REFERENCES

[1] Yung-giwu," *Medicalimage compression by sampling DCT coefficients" IEEE transactions on information technology in biomedicine, vol. 6, no. 1, march 2002*

[2] Yen-Yu Chen and Shen-Chuan "*Embedded Medical Image Compression Using DCT Based Subband Decomposition and Modified SPIHT Data Organization", National Cheng Kung University and ChengChou Institute of Technology, China*

[3] Zixiang Xiong, Kannan Ramchandran, *Michael T. Orchard, and Ya-Qin Zhang, "A Comparative Study of DCT- and Wavelet-Based Image Coding". IEEE transactions on circuits and systems for video technology, vol. 9, no. 5, august 1999*

[4] David Taubman, "*High Performance scalable Image Compression With EBCOT". IEEE Trans. Image Processing. Vol. 9, no. 7, July 2000*

[5] Yi-Ming Lin and Pei-Yin Chen, "*An Efficient Implementation of CAVLC for H.264/AVC", Proceedings of the First International Conference on Innovative Computing, Information and Control (ICICIC'06)*

[6] Anil. K. Jain, *Fundamentals of Digital Image Processing, PHI, New Delhi, 1995.*

[7] A.N. Netravali and B.G. Haskell, Digital Pictures: *Representation, Compression, and Standards (2nd Ed), Plenum Press, New York, NY (1995).*

[8] B.B.Mandelbrot*, Fractal Geometry of Nature, W. H. Freeman and Co, New York, 1982.*

[9] S.K. Mitra, C. A. Murthy, and M. K. Kundu, "*Partitioned Iterated Function System: A New tool for digital imaging", IETE Journal of Research,Vol. 16, No.5, Sep-Oct 2000, pp 279-298.*

[10] E. Kofidisi, N.Kolokotronis, A. Vassilarakou, S. Theodoridis and D. Cavouras, "*Wavelet-based medical image compression," Future Generation Computer Systems, vol. 15, no. 2, pp. 223-243, Mar. 1999.*

[11] D. F. Schomer, A. A. Elekes, J. D. Hazle, J. C. Huffman, S. K. Thompson, C. K. Chui and W. A. Jr. Murphy, *"Introduction to wavelet-based compression of medical images," Radiographics, vol. 18, no. 2, pp. 469-481, Mar. 1998.*

[12] B. J. Erickson, A. Manduca, P. Palisson, K. R. Persons, F. IV. Earnest, V. Savcenko and N. J. Hangiandreou,"*Wavelet Impression of medical images," Radiology, vol. 206, no. 3, pp. 599-607, Mar. 1998.*

[13] R. C. Gonzalez and R. C. Woods, "*Digital image processing*", *Mass. Addison-Wesley, 1992. [5] T. Acharya and A. K. Ray, Image Processing: Principles and Applications. Hoboken, NJ: John Wiley & Sons, 2005*

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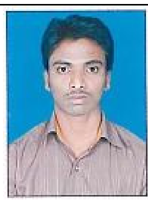

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