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PERFORMANCE ANALYSIS OF MEDICAL IMAGES APPLYING NOVEL MORPHO CODEC

D. Vijendra Babu[1] and N. R. Alamelu
[1]JNTU Hyderabad & Aarupadai Veedu Institute of Technology, Vinayaka Missions University, Chennai, India
[2]Sri Ramakrishna Engineering College, Coimbatore, India
E-Mail: dvijendrababu@gmail.com

ABSTRACT

A Novel Morpho Image Codec called L Shaped Morpho Codec (LSMC) based on Lifting Wavelet Transform (LWT) is proposed. LWT is used for decomposing Medical Image into various sub-bands. Significant pixels of sub-band is been tracked by LSMC in particular order. Morphological dilation immediately applied using L shaped structuring element if significant pixel is found. Experimental results show that the proposed LSMC outperforms standard codec's such as Set Partitioning in Hierarchical Trees (SPIHT) and Set Partitioned Embedded bloCK coder (SPECK) for Lossy and Lossless Compression for 512 x 512 & 1024 x 1024 images. The average bits per pixel (bpp) required for Lossless Compression by LSMC is less over by SPECK.

Keywords: LSMC, LWT, Morphological operation, SPECK, SPIHT.

1. INTRODUCTION

The recent advancement in Medical Imaging Techniques produce large amount of Medical Videos & Images. For reducing the storage space required by these Videos & Images an efficient Compression Technique is required. Scalable video coding is a latest Video Compression standard which is explained in [1]. This standard is tested on two different types of Videos namely Brain Computerized Tomography (CT) scan and Echocardiography. Spatial prediction, Temporal prediction and Context modeling is used as a new compression methods in [2] for compressing the Video sequences. This proposed method gives as a good Compression Ratio and excellent Image Quality. For compressing a Medical Video an Adaptive Particle Swarm Optimization (APSO) is developed in [3].

A combination of the Joint Photographic Expert Group-Lossless (JPEG-LS) and an inter frame coding with motion vectors to enhance the Compression performance of using JPEG-LS is introduced in [4]. A novel content-selective Video data processing and compression method based on the Discrete Wavelet Transform (DWT) is introduced in [5]. This method is adaptive to intra operative monitoring Video data and has a great scalability on real-time network bandwidth allocation. Motion-JPEG2000 is a new intra frame based Video Compression standard, which preserves best Image quality after Compression for use in high quality Video systems like HDTV-cameras, Medical Imaging cameras or Digital cinema cameras is presented in [6].

2. LIFTING WAVELET TRANSFORM

The proposed system for Medical Image Compression is based on Lifting Wavelet Transform (LWT). The Lifting Scheme is a system for both designing Wavelets and performing the DWT. The Lifting Scheme (LS) presented by Swelden's [7], [8] allows an efficient implementation of DWT.

Important property is about the ideal reconstruction is ensured by the structure of the LS itself. This allows latest transformations to be used. One such transformation is the integer wavelet transform (IWT) [9]. IWT can be used to have a unified lossy and lossless codec. The prediction of the differences observed between the two transforms [10], [11] becomes of primary importance for Embedded Coding schemes which compress data in Lossy and Lossless manners.LS implemented in Video Compression [12],[16] and SAR Image Compression [13],[17].

3. PROPOSED SYSTEM

In this paper, a Novel L Shaped Morpho Codec (LSMC) [14] for Medical Image Compression based on LWT is proposed. Due to high energy compaction property LWT is chosen which assigns most energy of the given input into a small number of coefficients. Each frame in the given Image sequence is decomposed by using LWT before applying the proposed search algorithm. The maximum level of decomposition is used in order to utilize the high energy compaction of LWT. By using L shaped structuring element as the proposed LSMC extends the encoding procedure of SPECK [15].

The final approximation image of the LWT transformed Image forms the first *S* set and also the root of the pyramid [14], [15]. The whole transformed image except the first *S* set forms the initial *I* set. Firstly, the *S* set is tested for their significance in the sorting pass against the threshold $n=n_{max}$.The set *S* is called significant if it contains at least one wavelet coefficient with greater than or equal to 2^{nmax}. If any pixel is found, then the significant list is updated with the position of that coefficient. Immediately, Dilation is applied to find other significant pixel using L shaped element which will increase the speed of the process as well as reduce the size of the bit stream by the searching pattern. After the encoding of *S* set, *I* set is tested for their significance against the same threshold n.

The octave band partitioning is applied to the set *I*, if it is significant. This partition generates three *S* sets and one reduced *I* set [14], [15]. The *S* sets are encoded by the aforesaid procedure and octave band partition is applied again to the reduced *I* set.

This procedure is repeated until the set *I* is empty and the sorting pass of the particular threshold is over. After the encoding of *S* set, *I* set is tested for their significance against the same threshold n. The *S* sets are encoded by the aforesaid procedure and octave band partition is applied again to the reduced *I* set.

This procedure is repeated until the set I is empty and the sorting pass of the particular threshold is over. The final encoding step of a particular threshold is the refinement pass. In this step, the pixels encoded during the previous sorting pass are refined. This whole process is repeated by decrement the threshold by 1.

4. EXPERIMENTAL RESULTS

The performance of the proposed Morpho codec for Medical Image Compression is evaluated by using 3 Brain CT and MRI Image sequences. The proposed algorithm is applied to 512x512 & 1024 x 1024 Medical images individually. To analyze the algorithm effectively, the codec is applied to achieve Lossy as well as Lossless Compression of Image. The performance measures used in the proposed LSMC in comparison with SPIHT and SPECK are Peak Signal to Noise Ratio (PSNR) at various bitrates and lossless bitrates.

The distortion is measured by the PSNR, as in (1).

$$PSNR = 10\log_{10}\frac{255^2}{MSE} \quad (1)$$

MSE is the Mean-Squared-Error between the original and reconstructed frames in the Image sequence.

Figure-1 shows the PSNR values obtained for 0.25 bpp of 512x 512 Medical Images. Figure-2 shows the PSNR values obtained for 0.5 bpp of 512x 512 Medical Images. Figure-3 shows the PSNR values obtained for 1bpp of 512x 512 Medical Images. Figure-4 shows the PSNR values obtained for 2 bpp of 512x 512 Medical Images. Figure-5 shows the PSNR values obtained for 3 bpp of 512x 512 Medical Images. Figure-6 shows the PSNR values obtained for Lossless Medical Images 512x 512.

Figure-7 shows the PSNR values obtained for 0.25 bpp of 1024x 1024 Medical Images. Figure-8 shows the PSNR values obtained for 0.5 bpp of 1024x1024 Medical Images. Figure-9 shows the PSNR values obtained for 1bpp of 1024x1024 Medical Images. Figure-10 shows the PSNR values obtained for 2 bpp of 1024x1024 Medical Images. Figure-11 shows the PSNR values obtained for 3 bpp of 1024x1024 Medical Images. Figure-12 shows the PSNR values obtained for Lossless Medical Images 1024x1024.

From Figure-6 & Figure-12, it is observed that the proposed codec produces better PSNR and Lossless bitrates than other codec's like SPECK and SPIHT. At lower bitrates the performance of the proposed codec is fairly same as SPIHT and SPECK due to the high energy compaction of LWT.

The number of bits available to encode the frame at lower bitrates is very less. Hence most of the bits are used to encode the approximation coefficients in the low frequency sub-bands. Also the significant coefficients are clustered in the low frequency sub-band for a particular threshold the encoding part of LSMC is same as SPIHT and SPECK, because all the coefficients are significant during Dilation.

For Lossless Compression, the proposed LSMC gives the best performance, showing the lowest rate on all Images. The average bits per pixel (bpp) required for Lossless Compression by LSMC is less over SPECK.

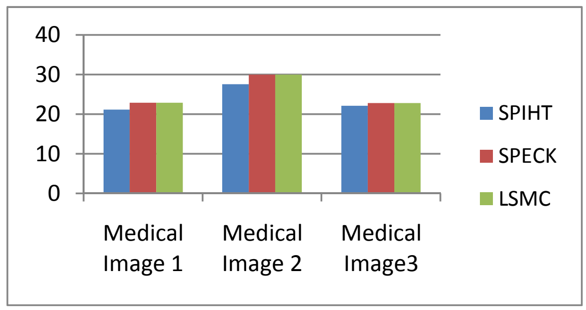

Figure-1. PSNR values obtained for 0.25 bpp of 512 x 512 medical images.

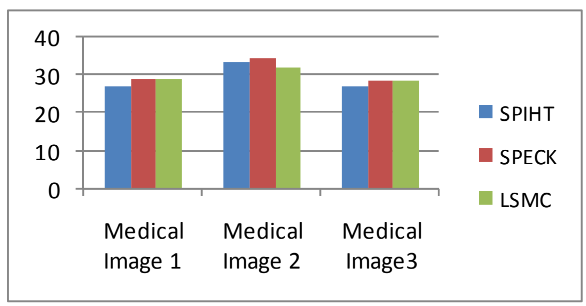

Figure-2. PSNR values obtained for 0.5 bpp of 512 x 512 medical images.

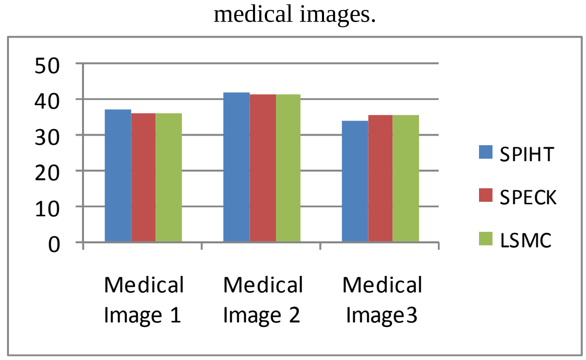

Figure-3. PSNR values obtained for 1 bpp of 512 x 512 medical images.

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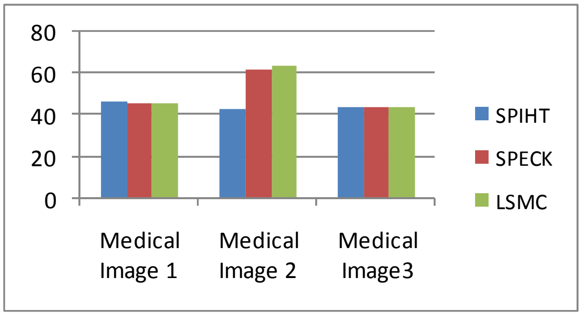

Figure-4. PSNR values obtained for 2 bpp of 512 x 512 medical images.

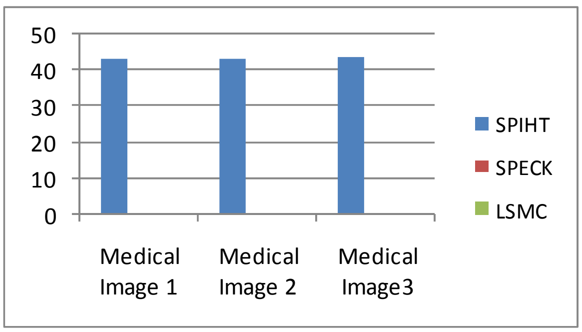

Figure-5. PSNR values obtained for 3 bpp of 512 x 512 medical images.

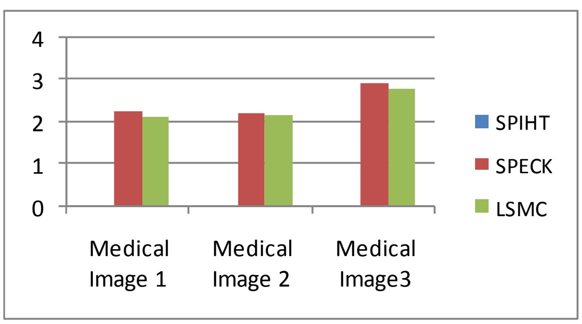

Figure-6. PSNR values obtained for lossless medical images of 512 x 512.

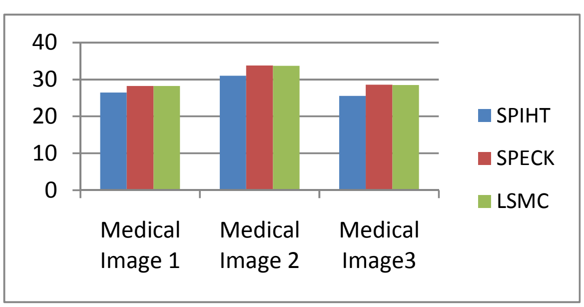

Figure-7. PSNR values obtained for 0.25 bpp of 1024 x 1024 medical images.

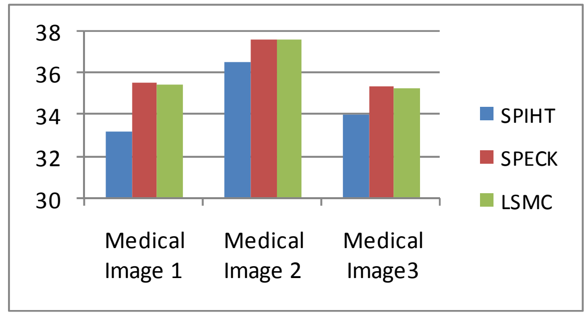

Figure-8. PSNR values obtained for 0.5 bpp of 1024 x 1024 medical images.

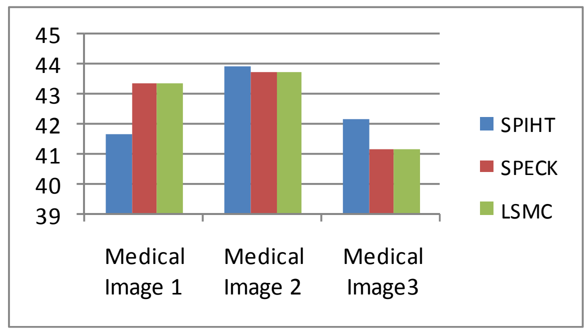

Figure-9. PSNR values obtained for 1 bpp of 1024 x 1024 medical images.

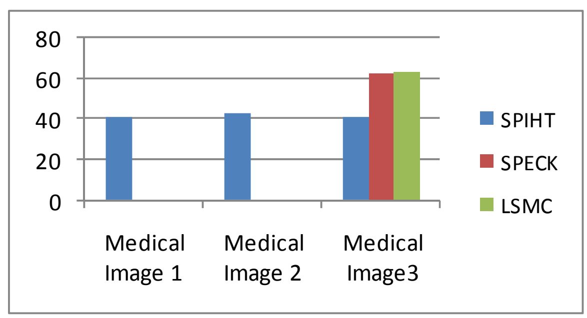

Figure-10. PSNR values obtained for 2 bpp of 1024 x 1024 medical images.

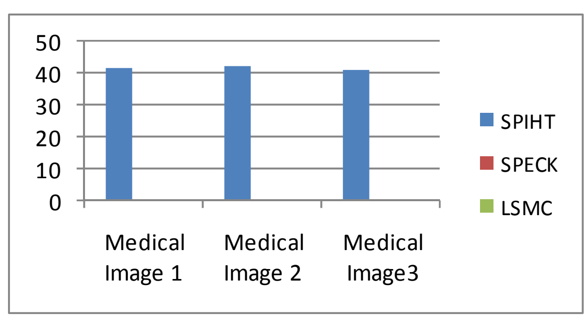

Figure-11. PSNR values obtained for 3 bpp of 1024 x 1024 medical images.

5. CONCLUSIONS

A Novel L Shaped Morpho Codec (LSMC) based on LWT for Medical Image Compression is proposed which was applied for size of 512x312 & 1024x1024. The proposed LSMC extends the encoding procedure by Morphological Dilation using L shaped structuring element. The results show better PSNR value over the other existing methods like SPIHT and SPECK at higher bit rates for Lossy Compression.

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