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MICROANGIOGRAM VIDEO COMPRESSION USING ADAPTIVE PREDICTION

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Abstract: Coronary angiography is an X-ray examination of the heart's arteries. This is an essential technique for diagnosis of heart damages. Image sequences from digital angiography contain areas of high diagnostic interest. Loss of information due to compression for regions of interest (ROI) in angiograms is not tolerable. Since Commercially available technology such as JPEG and MPEG do not satisfy medical requirements due to their severe blockartifacts. In this paper, a new compression algorithm that achieves high compression ratio and excellent reconstruction quality for video rate or sub-video rate angiograms is developed. The proposed algorithm exploits temporal spatial and spectral redundancies in backward adaptive fashion with Extremely low side information. An experimental result shows that the proposed scheme provides significant improvements in compression efficiencies.

1. ANGIOGRAM VIDEO

Recent advances in imaging technology have directly benefited diagnostic and corrective medicine. In the field of angiography, currently applied technology allows for the capture of an X-ray video of the heart which can be examined and processed in real-time. The current trend towards using digital representations of such data provides many tangible benefits over more traditional analogue-based approaches. These include the increased control over playback, identification and examination of key frames in the sequence. Also of benefit is the ability to apply image processing techniques to, for example, estimate the extent of a restriction of a coronary artery. Furthermore the digital representation of the Data allows for a more convenient approach to data storage and transmission. Due to the nature of the data however, and the typical duration of a procedure, the resulting uncompressed angiogram video is likely to be of the order of Mbytes in size. This can cause some difficulties with the storage of the data, with particular problems concerning the transmission of the video data elsewhere, especially if the transmission bandwidth available is low. This problem would be alleviated if an efficient means of compression could be found.

1.1. THE NEED FOR COMPRESSION

Unfortunately, the logistics concerning angiogram video, as with much medical imaging, makes such a vision hard to realize in practice. Typical image sizes are 512x512 (or even 1024x1024) pixels, taken at 30 frames/sec with at least 8 bits of resolution. A typical procedure may be of the order of 5 minutes resulting in approximately 2.5 GBytes of raw data. At a constant data rate of 64Kbit/sec it would take 80 hours to transmit this quantity of data, and even at 10Mb/sec it would take 30 minutes. From this it is clear that a practical system for transmitting angiogram video from one hospital to another requires a high bandwidth connection, but even then a wait of 30 minutes may be considered unacceptable, especially if a semi-real-time diagnosis is required. Matters may be improved considerably by compressing the video stream. Due to the sensitivity of the data however, only lossless or near-losslessalgorithms can realistically be used. Unfortunately, the tight constraints imposed by lossless compression usually limit the compression ratio to about 2 or 3:1. For diagnostic purposes, it is essential that the compression process causes no tangible loss of detail and introduces no noticeable artifacts which could be misinterpreted as being pathological in nature. Little research has been done specifically regarding the compression of angiogram video. Unfortunately, given the unique structure of the data, video compression results relating to more conventional types of video (e.g. for digital television), for which there has been a great deal of research, do not necessarily apply here.

1.2. INTRODUCTION

DUE to its importance in multimedia applications, most research on video compression has centered on lossy video compression where the focus is on achieving a good tradeoff between the reconstructed quality and the compression ratio. Current lossy video compression provides substantial compression efficiency at the cost of minimal degradation of quality. Historically, significantly less interest has been paid to the development of lossless video compression algorithms. Lossless video compression is important to applications in which the video quality cannot tolerate any degradation, such as archiving of a video, compression of medical and satellite videos, etc. Recently, there has been increasing interests in developing lossless video compression techniques [1]–[9].Currently, there are several methods available for digital image compression. In applications where some information loss is acceptable, lossy methods are often used, because these tend to be have higher coding efficiency. However, in applications such as medical imaging, remote sensing and legal imaging, the data validity and precision must be preserved for subsequent reconnaissance; therefore lossless approaches tend to be more adequate. High image resolutions and depths are ubiquitous in medical imaging, and such images usually are stored for long periods of time for legal reasons. Lossless image compression methods that explore correlations among spatially adjacent pixels are popular now a day. Such methods have been applied in static image lossless coding, and can be divided into three categories: transform-based methods, methods based on predictors, and multi-resolution techniques. Dynamic images like videos usually are redundant in the spatial and in the temporal sense (i.e. pixels in adjacent frames tend to be correlated to some degree). Thus, compression techniques for videos often explore the spatial and temporal redundancy in the data (e.g. MPEG-2 [5], H.264 [6] and others [7]), work in this direction. Prediction based schemes have been successful in lossless coding of still medical images, such as JPEG-LS [8] andCALIC [9].

2.0 PIXEL BASED PREDICTION

It is well known that the choice of block-size used in motion compensation is always a tradeoff between prediction accuracy and the size of side information. Smaller and more numerous blocks can provide smaller prediction residuals but result in more side information and more motion vectors. Choosing a large block size means a small number of bits for the side information, but also lower prediction efficiency resulting in a larger prediction residual. Even in the scheme proposed in [9], which requires no transmission of motion vectors, there still exists a similar tradeoff between the prediction accuracy and the size of side information. By considering the above tradeoff, we introduce a new lossless coding scheme with two key points: It adopts a pixel-based motion compensation concept in order to minimize the prediction residual, and it only needs to transmit fixed size side information, which is also extremely low compared to the size of the original video sequence.This way of prediction makes the adaptive to be the best compared to previous algorithms (i.e. JPEG, CALIC).

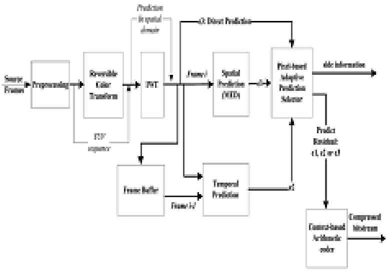


Fig.1.block diagram of proposed algorithm

In this section, we present the proposed adaptive pixel-based prediction scheme which exploits the redundancies in the wavelet domain or in the spatial domain with fixed size side information. As shown in Fig. 1, the proposed scheme consists of the following main steps: preprocessing, adaptive symbol prediction, adaptive prediction mode selection, and context-based arithmetic coding of the prediction residuals. Preprocessing aims to determine the operational domain of temporal and spatial redundancies. The candidate operational domains are the wavelet domain and the spatial domain. In the adaptive symbol prediction step, three separate predictors are utilized to reduce the spatial and temporal redundancies: a novel temporal predictor, a spatial predictor and a direct predictor. In the adaptive prediction mode selection step, a predictor can be selected adaptively from three candidates based on the causal previous predictive information to maximize the prediction performance.

2.1. SPATIAL PREDICTION

To reduce the spatial redundancy, a prediction is computed based on the neighboring symbols in the same frame as the symbol to be encoded (here, we use the term symbol because it can be a pixel in the spatial domain or a wavelet coefficient in the wavelet domain). In the proposed scheme, we use a simple but robust spatial predictor, the median edge detector MED), as used in JPEG-LS [11].MED estimates the symbolto be encoded based on the values of the three previously encoded neighboring symbols. We use p(x,y) to represent the symbol to be encoded that is located at (x,y) in frame . The spatial predicted value of p(x,y) is represented as pi(x,y), which is given by

$$p_i(x,y) = \begin{cases} \max(A,B) & \text{IF } C \geq \max(A,B) \\ \min(A,B) & \text{IF } C \leq \min(A,B) \\ A+B+C & \text{OTHERWISE} \end{cases}$$

Where $A = p_i(x-1,y)$, $B = p_i(x,y-1)$ and

$C = p_i(x-1,y-1)$

Thus spatial prediction residual is

$$e_1 - p(x,y) - p_i(x,y) \qquad (1)$$

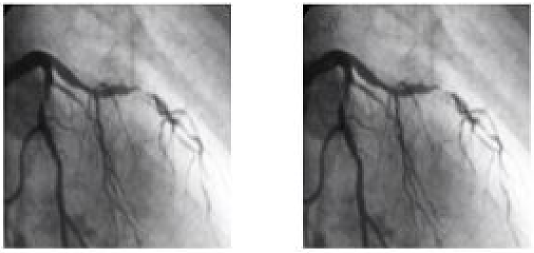


Fig2. frame [i] and frame [i-1] of an angiogram video1

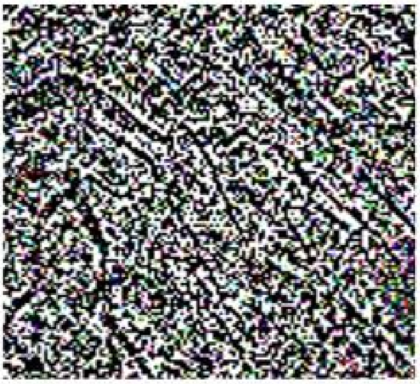


Fig3. integer wavelet transform of video1

2.2. TEMPORAL PREDICTION

Let pi(x,y) be the symbol to be encoded. The proposed temporal predictor aims to find the best matched symbol in reference frame [i-1],which is denoted as the temporal predictor piT(x,y).Instead of piT(x,y) exploiting the motion activity of between adjacent frames directly, the predictor investigates the motion activity of the target window of pi(x,y) in frame i and frame [i-1] within a search range W*H as illustrated in Fig.4 ,where the target window is composed of the upper-left neighboring symbols of p(x,y)

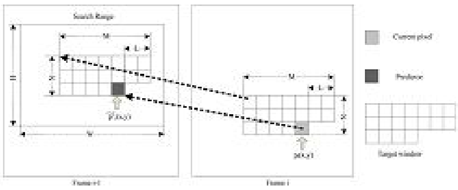


Fig.4. temporal prediction of symbol $p_i(x,y)$

The temporal predictor of symbol pi(x,y) searches and locates the best matched target window in frame [i-1] which achieves the minimum cumulative absolute difference (CAD) within the search range, where

$$\mathrm{CAD}(d)=\sum_{m,n\varepsilon d} pi(x,y) - pi(x+m,y+n) \qquad (2)$$

where d denotes the target window, and pi(x,y),pi-1(x,y) the symbol values of the current frame and the reference frame , respectively, and where a motion vector (m,n) is determined for the region -W $\le m \le W, -H \le n \le H$ TO minimize the CAD Similar to block motion compensation techniques, the best motion vector for the target window with the minimum CAD is determined by target window with the minimum CAD is determined by (mo,no) =arg{ min(CAD(d)}Where (mo,no) indicates the motion displacement of the target window pi(x,y). Then, the temporal predictor of can be obtained by $pi^T(x,y)$ =pi(x+m,y+n) (3)

Where temporal error is

e2 = pi(x,y)-$pi^T(x,y)$ (4)

2.3. DIRECT MODE

If a video sequence is to be processed in the wavelet domain, then we use another prediction mode which is similar to the concept of direct sending mode as described in [9]. Because of the energy compaction property of the IWT, the wavelet coefficients in the high frequency sub bands (LH, HL, HH) usually have small amplitudes, which may be smaller than the amplitudes of the spatial prediction residuals and temporal prediction residuals. Therefore, in this case the wavelet coefficients are encoded and transmitted directly denoted as e3.

2.4. ADAPTIVE PREDICTION MODE SELECTION

This is accomplished by utilizing a simple but effective backward adaptive prediction mode selector. The scheme adaptively selects the predictor among three candidates (e1, e2, or e3) based on previous prediction accuracy.

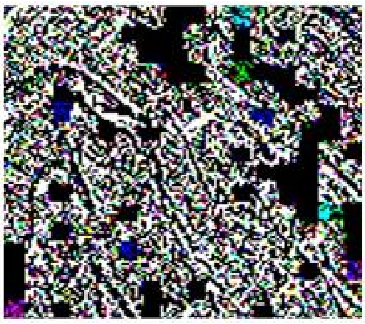


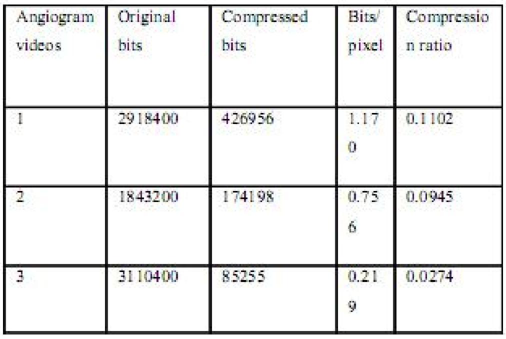
Fig.5 .Final errors:e1,e2,e3 video1

2.5 CONTEXT MODELLING

Context modelling is used for efficient coding of the prediction residuals. By utilizing suitable context models, the given prediction residual can be encoded by switching between different probability models according to already encoded neighboring symbols of the symbol to be encoded.

3. RESULTS

We tested the proposed scheme using standard color video sequences; all experiments were conducted to get the best performance. The proposed scheme with JPEG-LS, CALIC, on various YUV and RGB sequences is better, which verify that our approach achieves significant performance enhancement with respect to JPEG-LS, CALIC in terms of bit rate. The table1 show the bite rate and compression ratio for different video sequences for the proposed algorithm.



Angiogram videos	Original bits	Compressed bits	Bits/ pixel	Compression ratio
1	2918400	426956	1.170	0.1102
2	1843200	174198	0.756	0.0945
3	3110400	85255	0.219	0.0274

Table1: Results of bite rates and compression ration for various video sequences

4. CONCLUSIONS

In this paper, a new scheme for lossless coding medical video sequences is presented. It exploits spectral, spatial, and temporal redundancies and adaptively selects the best predictor out of a set of predictors without using any side information. The results show a good compression ratios and better bit rate compared to previous compression algorithms.

5. REFERENCES

[1] N. D. Memon and K. Sayood, "Lossless compression of video sequences," IEEE Trans. Commun., vol. 44, no. 10, pp. 1340– 1345, Oct. 1996.

[2] K. H. Yang and A. F. Faryar, "A context-based predictive coder for lossless nd near-lossless compression of video," in Proc. Int. Conf. Image Processing, Sep. 2000, vol. 1, pp. 144–147.

[3] E. S. G. Carotti, J. C. De Martin, and A. R. Meo, "Low-complexity lossless video coding via spatio-temporal prediction," in Proc. Int. Conf. Image Processing, Sep. 2003, vol. 2, pp. 197–200.

[4], ------"Backward- adaptive lossless compression of video sequences ,in Proc. IEEE Int. Conf. Audio, Speech, Signal Processing, Apr. 2002, pp. 3417–3420.

[5] D. Brunello, G. Calvagno, G. A. Mian, and R. Rinaldo, "Lossless compression of video using temporal information," IEEE Trans. Image Process., vol. 12, no. 2, pp. 132–139, Feb. 2003.

[6] B. Martions and S. Forch gammer, "Lossless compression of video using motion compensation," in Proc. IEEE DCC, 1998, pp. 560–589.

[7] Z. Ming-Feng, H. Jia, and Z. Li-Ming, "Lossless video compression using Angiogram videos Original bits Compressed bits Bits/ pixelCompressio n ratio 1 2918400 426956 1.1700.11022 1843200 174198 0.7560.09453 3110400 85255 0.219 0.0274combination of temporal and spatial prediction," in Proc. IEEE. Int. Conf. Neural Networks Signal Processing, Dec. 2003, pp.1193–1196.

[8] Y. Gong, S. Pullalarevu, and S. Sheikh, "A wavelet-based lossless video coding scheme," in Proc. Int. Conf. Signal Processing, 2004, pp. 1123–1126.

[9] S.-G. Park, E. J. Delp, and H. Yu, "Adaptive lossless video compression using an integer wavelet transform," in Proc. Int. Conf. Image Processing, 2004, pp. 2251–2254.

[10] S.-G. Park, "Adaptive lossless video compression," Ph.D. dissertation, School Elect. Comput. Eng., Purdue Univ.,West Lafayette, IN, Dec.2003.[11] JPEG-LS, Lossless and Near-Lossless Coding of Continuous Tone Still Images, ISO/IEC JTC1/SC 29/WG 1, Jul. 1997.

[12] N. Memon and X. Wu, "Context-based,adaptive, lossless image coding," IEEE Trans. Commun., vol. 45, no. 4, pp. 437–444, Apr.1997.

[13] A. R. Calderbank, I. Daubechies, W. Sweldens, and B. L. Yeo,"Wavelet transforms that map integers to integers," Appl. Comput.Harmon. Anal., vol. 5, no. 3, pp. 332–369, Jul. 1998.

[14] "Lossless image compression using integer to integer wavelet transforms," in Proc. IEEE Int. Conf. Image Processing Oct. 1997, vol.1, pp. 596–599.

[15] K. Sayood, Introduction to Data Compression, 2nd ed. San Mateo, CA: Morgan Kaufmann, 2000.

[16] D. S. Taubman and M. W. Marcellin, JPEG2000 Image ompression Fundamentals Standards and Practice. Norwell, MA: Kluwer, 2002.

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