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Research on Multiple Descriptions Coding for Images Stratified Sampling Based on WMSN

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Abstract: This paper analyzed the stratified sampling and transmission robustness problems of image with wireless multimedia sensor networks (WMSN) which is under the condition of packet loss and error, at the same time, devised a stratified sampling image multiple description coding (MDC) method. This technology can make full use of the characteristic of wavelet coefficient structure by wavelet transformation. According to different decomposition layers, selecting the corresponding method to sampling, it's useful to achieve the goal of multiple description coding transmission of image data. At the receiving end, on the other hand, the original image can be reconstructed by nonlinear algorithm after a single description is obtained. *Copyright © 2013 IFSA.*

Keywords: Oriented to WMSN, Stratified sample of image, Multiple description coding.

1. Introduction

As a typical representative of the new wireless sensor network (WAN), Wireless multimedia sensor (WMSN) has been widely used in the intelligent building, medical, environmental monitoring, etc. WMSN introduced the technology of video sensor nodes into WNS, and then formed an Ad - hoc self-organizing networks which can transmit video data and image. In WMSN data transmission process, limited by its basic characteristics, for example, wireless channel can easily affected by the network bandwidth and the impact of node energy limited, then the network system often arise the phenomenon such as packet error or missing, and can produce certain effect to image data, resulting in the loss of data for the whole, greatly reduces the image quality at the receiving end, the end of WMSN network service performance has a serious adverse effect. At present, how to lower energy consumption WMSN network, improve the quality of image transmission, provides the guarantee for the improvement of network service quality, has gradually become the wireless multimedia sensor network the focus of researchers. In the process of wireless data communication, traditionally used wrong hidden EC, ARQ and FEC error correction coding protocol technology to tackle the problem of packet loss and error code but unable to get ideal effect, this paper proposes a practical and effective processing algorithm scheme of packet loss and code error problem.

2. Multiple Description Coding

Multiple description coding need to divide the source into a separate stream, in different channels,

source of multiple description can independently the transmission, the receiver can on the basis of different transmission stream right, choose corresponding recovery stream method, the main reason is that all channels and description at the same time, the probability of error is small, usually described any transmission recovery, decoder to be able to restore the signal transmission quality. If multiple descriptions usually recover right transfer, the signal quality is higher.

As shown in Fig. 1 is described two cases of MDC. The central channel is for the central decoder, and the edge of the channel is for the two edge decoder.

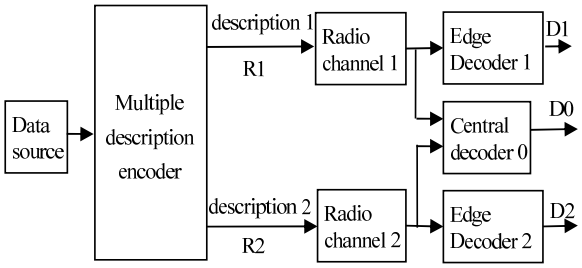


Fig. 1. Schematic of two descriptions.

In the case of two describes the MDC, if there is only one channel to the receiver transmit signal correctly, the reconstruction signal will occur serious distortion, distortion degree and significantly more than the minimum value. If the two signals are able to correct delivery to the receiving end, a signal will be affected by other signal increases, the influence of values so as to realize the signal reconstruction is greatly increased [1].

Suppose D0, D1 and D2 represent edge decoder 1, 2 and the central decoder distortion rate of 0, R1, R2 represent bit rate by two descriptions, then it can be expressed as follows:

$$\begin{cases} D0 \geq D(R2+R1) \\ D1 \geq D(R1) \\ D2 \geq D(R2) \end{cases}, \quad (1)$$

Multiple description image coding is the core issue of multiple equilibrium data stream execution ground, including conventional technology, multiple description coding based on the extended space, on the basis of the transformation of multiple description coding and multiple description coding based on the scalar quantization and so on, among them, expand the space based multiple description coding and multiple description coding based on the transformation technology can use transform introducing redundancy, multiple description coding based on the scalar quantization techniques can use different quantization precision to the introduction of the redundancy, thereby in a certain extent, improve the amount of data channel transmission [2].

WMSN and node will be affected by network bandwidth, the network resources such as the limitation of various factors, so the image before sent to the node, usually requires fusion preprocessing, such as compression, so as to increase the use of the network time, maximum save the energy consumption in the process of data transmission effectively. If through the introduction of the above mentioned acute multiple description coding redundancy methods, then although can achieve data transmission robustness enhancement, but will greatly increase the amount of communication data network, thus shortening the service life of the network, therefore, how to don't, on the basis of the introduction of redundant to multiple description coding gradually became the focus of researchers [3].

Wavelet transform can realize image completely eliminate redundancy, image compression tool of choice is the image of efficient coding. Multiple description coding based on wavelet transform has become the key to the video and image, etc. Multiple description coding method [4].

3. Stratified Sampling Multiple Description Coding

In this paper, according to the basic characteristics of WMSN, based on the wavelet transform of stratified sampling analysis of multiple description coding technology are discussed in this paper, so as to realize the redundancy is not increased, on the basis of multiple description image transmission to and implemented the gradual improvement of the image transmission robustness [5], as shown in Fig. 2.

Original image is first, the wavelet transform is used to realize the improvement of the algorithm, based on the wavelet coefficients of the different structural characteristics, select the corresponding decomposition template implementation of sampling. Sampling form of multiple description can implement entropy coding and EZW coding respectively, and the multiple wireless channel transmission, according to describe the receipt number is different, at the decoding end use different EZW coding and entropy coding for central decoder and decoder of the original image reconstruction [6].

3.1. Quincunx Subsampling Multiple Description

Wavelet coefficients can be formed through a variety of methods, common method need to first real-time sampling airspace of plum, produce multiple description, and description of the implementation of coding transmission respectively, as shown in Fig. 3.

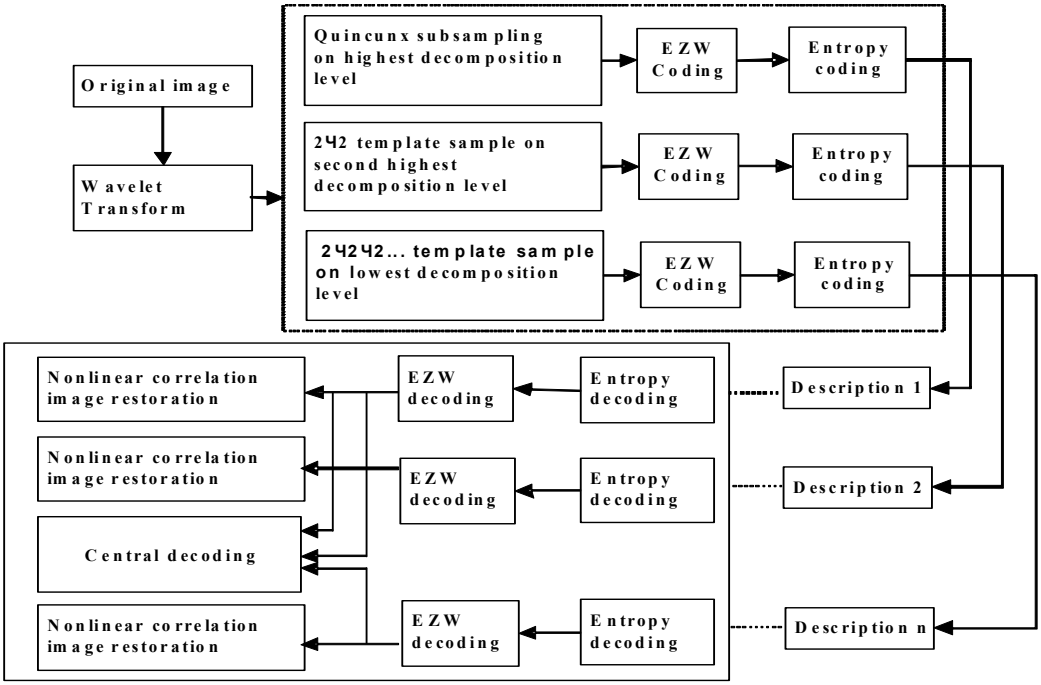


Fig. 2. The Structure of stratified sampling multiple description image coding.

(a)Wavelet coefficients (b)Sample description 1 (c)Sample description 2

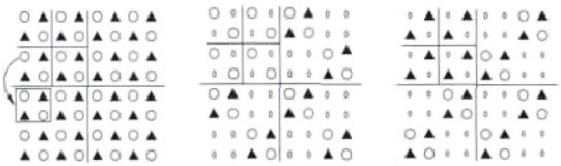
Fig. 3. Multiple description based on quincunx subsampling.

Among them, the Fig. a is through two layers of wavelet decomposition process of 8 x 8 sub-band image distribution, produces two describes the program as follows: first, all unified according to the quincunx subsampling distribution of decomposition level of wavelet coefficients of the implementation of peer, and generate b and c in the Fig. two description; Second, using the corresponding channel respectively for two description coding and transmission [7].

This description method without introducing redundancy, however, because of the quincunx sampling multiple description to describe allocated to two times zero tree wavelet coefficient of decomposition layers. Time decomposition coefficient in the layer structure will be assigned to the description of two, and then destroy the wavelet zero-tree structure, and a direct impact on subsequent EZW algorithm coding efficiency, the main reason is that the EZW coding algorithm commonly used wavelet zero-tree structure, so as to improve the efficiency of the code, realize high-efficiency image compression [8].

3.2. Sampling Multiple Description Layered Extension

Shown in Fig. 4 is expansion coefficient of samples produced by multiple description layered distribution, mainly includes two basic steps: first, choose a part time decomposition level zero tree structure, and decomposition of top layer selected sampling multiple description of clubs and sampling coefficient of expansion for four constitute the retain samples values, using zero filling coefficient of discarded, and generate in Fig. 3 b, c, two kinds of description, therefore, if use three layers of wavelet decomposition, will form 16 coefficient is a kind of high frequency coefficient sample extension structure, and use the filling coefficient of discarded 0. Second, description of all the implementation algorithm of EZW coding respectively, and use the corresponding channel transmission [9].



(a) Wavelet coefficients (b) Sample description 1 (c) Sample description 2

Fig. 4. Stratified sampling multiple description.

Layered extended sample description of main target is that wavelet transform can realize image

data redundancy greatly reduced, at the same time, can be based on the coefficient of distribution, maximum limit will retain the original zero tree wavelet transform coefficient of structure, produce two sampling methods described above, its core is that according to retention time extension mode decomposition level of wavelet coefficients [10]. In subsequent EZW coding, because the initial threshold T is greater than the filling coefficient of zero, and thus determine the zero coefficient is zero roots, without scanner coefficient, again so, will have larger influence to the encoder, so as to achieve the improvement of the effectiveness of the algorithm [11].

EZW near the quantitative way, step by step is the implementation of wavelet coefficients coding, this algorithm has more than support rate decoding and forming embedded code stream and other obvious advantages, and therefore more suitable for WMSN system, based on the network situation, to ensure the receiving end of coding rate for real-time adjustment [12].

At a specific time period, assuming the WMSN belongs to a kind of random network channel smooth channel, in between the receiver and the sender multiple paths, each path of the probability of errors or lost data packets are Pi [13]. Multiple description for Ci, sending images under the Ri bit rate describe Ci image distortion caused by rate of Ei, therefore, the receiver is obtained by multiple description image fidelity can be expressed as follows:

$$\prod_{i=1}^{n}(1-Pi)(1-Ei), \tag{2}$$

If the required image fidelity for the receiver is η_{Th}, which means the image information entropy (H), peak signal to noise ratio (PSNR) and other indicators, then there is the following formula:

$$\min\left\{\prod_{i=1}^{n}(1-Pi)(1-Ei)\right\} \geq \eta_{Th}, \tag{3}$$

Because stratified sampling of multiple description coding end multiple description belongs to a kind of balance, the image distortion is the same contribution that the E1 = E2 =... = Ei, therefore, Ri bit rate coding end distortion under Ei should meet the following conditions:

$$E \geq 1-\left\{\eta_{Th} / \min[\prod_{i=1}^{n}(1-Pi)]\right\}^{1/n}, \tag{4}$$

After get the corresponding R bit rate, EZW coding end algorithm can be based on the size of the bit rate R, in each scanning section will stream stage, so as to achieve the needs of the channel transmission [14].

4. Result Analysis

4.1. The Test of Multiple Description Coding

To stratified sampling testing the effectiveness of the proposed multiple description coding algorithm, this paper chose 512 x 512 resolution of Lena image real-time validation, implementation algorithm of image by 5/3 when the ability of the two layers of wavelet decomposition, extended with mentioned above stratified sampling method and sampling method of clubs and the decomposition coefficients is transformed into two different description, thus ensuring to encode described by EZW algorithm, in the process of test assumes that the bit rate range between 0.25 to 1.00 BPP, Table 1 shows the results of the algorithm time-consuming test on the conditions of different bit rate [15].

Table 1. The results of algorithm's time consuming by different bit rate.

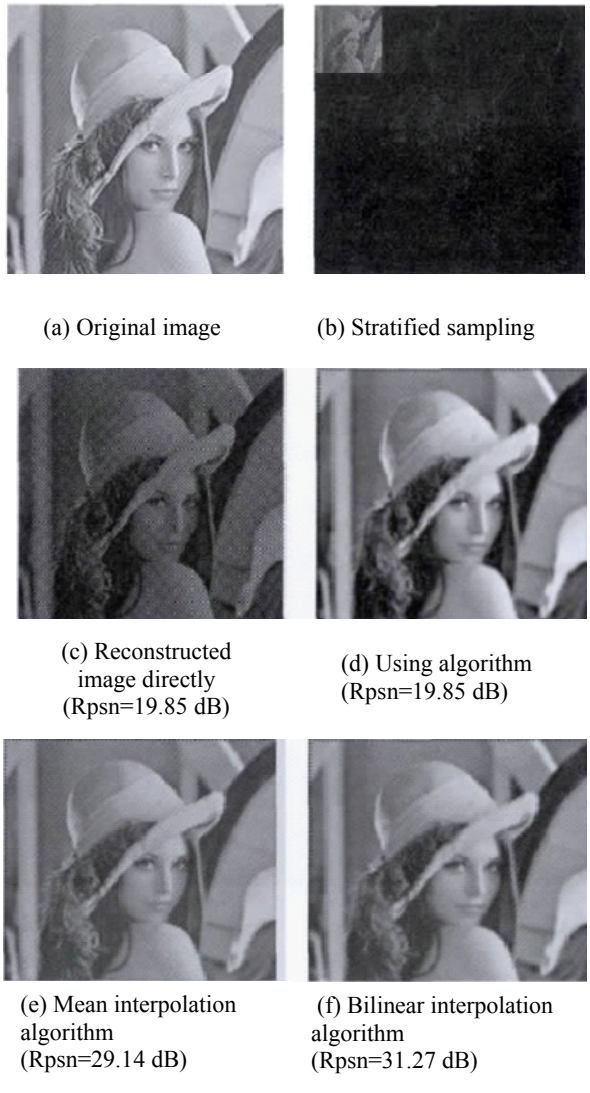
Bit Rate/bpp		1.00	0.50	0.25
Time consuming of stratified sampling expansion/s	Description 1	16.41	16.41	16.41
	Description 2	15.97	15.97	15.97
Time consuming of quincunx subsampling /s	Description 1	12.57	12.57	12.57
	Description 2	12.95	12.95	12.95

By the result of Table 1, it shows that in the same rate, on the basis of whether it is a low compression ratio 1.00 BPP or 0.25 BPP high compression rate, layered extension sampling coding compression efficiency all have different degrees of improvement, and less and less time-consuming, at the same time, lower compression ratio based on stratified sampling coding compression efficiency not higher. Test result analysis shows that layered extended sample code formed by two description, the time consuming level is lower than about 24.06 % of the plum blossom sampling coding, the main reason is that the layered extension sampling coding with wavelet decomposition coefficients, taking advantage of the more efficient, to achieve the maximum of wavelet zero-tree structure, so as to maximize the efficiency of the coding [16].

4.2. Nonlinear Interpolation Algorithm Test

As shown in Fig. 5 is the same choice, on the basis of Lena image nonlinear correlation test results of interpolation algorithm. After two layers of wavelet transform, the original image can be extended with stratified sampling coding for two of the original description, among them, the graph is

one of the hierarchical b extended sampling coding of description. Two descriptions in entropy coding and EZW coding processing, the book to the sink node. If sink node also won two descriptions, it can reconstruct the original image through the wavelet inverse transformation technology. If it is just a description direct wavelet inverter produces c as shown in Fig. image reconstruction results [17]. Fig. d to Fig. f are the sink node to obtain a description, based on the algorithm of image reconstruction which is formed by the different results.



(a) Original image (b) Stratified sampling

(c) Reconstructed image directly (Rpsn=19.85 dB) (d) Using algorithm (Rpsn=19.85 dB)

(e) Mean interpolation algorithm (Rpsn=29.14 dB) (f) Bilinear interpolation algorithm (Rpsn=31.27 dB)

Fig. 5. Nonlinear correlation interpolation results.

Experiment results show that, the sink node to obtain a description, if not through the processing image interpolation algorithm, the image restoration after will produce more severe Mosaic phenomenon, image peak signal-to-noise ratio will decrease. Through nonlinear interpolation algorithm implementation after image reconstruction, Rpsn indexes and subjective image quality of reconstructed image will be different levels of improvement. Writer will double linear interpolation algorithm, the nonlinear interpolation algorithm is compared with the mean difference algorithm, the results confirmed that the bilinear interpolation and the mean difference of image edge clarity is poorer, the image is fuzzy. Algorithm described in this paper, restore image peak signal-to-noise ratio of 34.62 dB, and significantly higher than the bilinear interpolation of 31.27 dB and the mean difference of 29.14 dB. On the edge of the image resolution and image clarity, the algorithm is described in this paper, an edge, and the subjective quality effect the better [18].

5. Conclusion

In summary, the author based WMSN prone during transmission data loss and packet error problem, we propose a method to improve the image transmission reliability, and according to the basic characteristics of WMSN, a wavelet-based non-linear image interpolation algorithm and hierarchical extended sampling multiple description coding techniques, and use this method to rebuild the original image restoration, the findings confirm that, compared with other traditional algorithms, algorithms described in this article, based on the same bit rate can be achieved image data gradually increase coding efficiency [19]. Meanwhile, the algorithm can be obtained only on the basis of a description, to achieve the quality of the original image reconstruction gradually improved, and to extend the use of the network time, reducing the energy consumption of the node, to improve the image data transmission network WMSN robustness [20].

References

[1]. S. H. Zhu, C. Wu, Y. Fang, Multiple description video coding based on visual perception tablet group, *Chinese Journal of Computers*, Vol. 30, Issue 5, 2007, pp. 861-868.

[2]. S. W. Liu, Z. Ma, Video multiple description coding based on balanced multi-wavelet image transform, *Chinese Journal of Image and Graphics: Series A*, Vol. 9, Issue 12, 2004, pp. 1466-1472.

[3]. S. B. Zhang, W. Ye, C. Y. Zhong, Mixed sampling multiple description image coding, *Journal of Beijing Normal University*, Vol. 4, Issue 44, 2008, pp. 391-392.

[4]. S. M. Yu, S. He, L. Fan, A multiple description image coding method based on DCT, *Application Research of Computers*, Vol. 2, Issue 44, 2004, pp. 246-247.

[5]. S. J. Lu, Q. Zhang, Z. Xu, L. Wu, Multiple Description Coding low-resolution image super-resolution reconstruction, *Optical Engineering*, Vol. 11, Issue 39, 2012, pp. 95-97.

[6]. S. H. Xian, Z. Fu, Q. Wan, L. Wu, Block-based adaptive super-resolution algorithm, *Optical Engineering*, Vol. 9, Issue 38, 2011, pp. 119-123.

[7]. S. G. Fan, C. Zhang, M. Yuan, Multiple description coding based transmission performance WMSN, *Journal of Beijing University of Posts and Telecommunications*, Vol. 6, Issue 35, 2012, pp. 70-73.

[8]. S. M. Yu, F. Xiao, G. Jiang, F. Lee, One kind of macro block division multiple description video coding method, *Chinese Journal of Image and Graphics*, Vol. 4, Issue 11, 2006, pp. 496-472.

[9]. S. G. Xiao, C. Wu, F. Zhang, Y. Lee, SPIHT-based multiple description coding region of interest, *Chinese Journal of Computers*, Vol. 1, Issue 29, 2006, pp. 171-176.

[10]. S. Z. Nan, Y. Lv, F. Wu, B. Yin, Based on Directional Lifting Wavelet Transform Multiple Description Image Coding, *Acta Automatic Sinica*, Vol. 6, Issue 33, 2007, pp. 567-576.

[11]. S. H. Zhao, Y. Lv, F. Wu, B. Yin, Multiple Description Coding of Research and Prospect, *Journal of Communications*, Vol. 6, Issue 33, 2007, pp. 567-576.

[12]. S. C. Lin, Image/video Multiple Description Coding and Transmission, *Journal of Beijing Jiaotong University,* Vol. 1, Issue 29, 2006, pp. 171-176.

[13]. S. B. Pang, Y. Zhang, X. Xu, Adaptive image interpolation in super-resolution image reconstruction using, *Hefei University of Technology (Natural Science)*, Vol. 7, Issue 1, 2006, pp. 825-826.

[14]. S. Q. Chen, C. Cai, Based on hierarchical multiple description coding, *Chinese Journal of Image and Graphics*, Vol. 1, Issue 13, 2008, pp. 47-52.

[15]. S. H. Bai, Multiple description image / video coding research, *Beijing Jiaotong University (Doctoral Dissertation)*, Vol. 6, Issue 1, 2008, pp. 12-13.

[16]. S. Q. Lee, Q. Hao, Y. Song, Dongsheng Wang, Stratified sampling for image WMSN Multiple Description Coding, *Journal of Beijing Jiaotong University*, Vol. 6, Issue 33, 2013, pp. 594-595.

[17]. A. S. Lukin, D. Kubasov, High-quality algorithm for Bayer pattern interpolation, *Programming and Computer Software*, Vol. 6, Issue 30, 2004, pp. 347-348.

[18]. S. Khelil, B. Reh, A. Djebari, Multiple description wavelet-based image coding using correlating transforms, *AEU-International Journal of Electronics and Communications*, Vol. 6, Issue 20, 2007, pp. 411-413.

[19]. I. F. S. Akyildiz, T. Melodia, K. R. Chowdury, Wireless multimedia sensor networks: a survey, *IEEE on Wireless Communications*, Vol. 6, Issue 14, 2007, pp. 32-33.

[20]. S. El-Khamy M. M. Hadhoud, M. I. Dessouky, Efficient implementation of image interpolation as an inverse problem, *Digital Signal Processing*, Vol. 2, Issue 15, 2005, pp. 137-138.

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