Side Information Update Method of Error Correction Decoder for Distributed Video Coding

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Abstract

A new side information update method of error correction decoder for distributed video coding is proposed. This method improves the quality of side information. The side information values are updated using both the values of quantization index and its quantization interval. Side information update method reduces the amount of parities transmitted to decode quantization index.

Keywords: *Distributed video coding, DVC, side information*

1. Introduction

In previously released video compression techniques, most of the required arithmetic operations for information compression are performed at the encoder. These computation intensive encoding techniques are developed for DVD, Blu-Ray and public TV broadcasting service.

But these video coding techniques are not suitable for small multimedia device because of the limitations such as the insufficient computing power of battery powered device. To overcome such limitations, DVC (distributed video coding) is a promising candidate.

Distributed lossless source coding technique began with Slepian-Wolf theorem in the 1970s [1]. It was then extended to lossy compression after the study of Wyner and Ziv [2]. DVC's based on this pioneering work, have been studied by many researchers including Stanford University [3], Berkeley University [4] and Europe's joint research group [5, 6].

In DVC encoder, there is no loop architecture for prediction coding. So frames are coded independently like I frame of conventional video coding standard. Instead of prediction coding, the DVC encoder performs only simple operation like error correction encoding. DVC decoder, however, has to carry out most of the complex operations including error correction decoding and motion estimation and compensation which were components of the encoder in other conventional video coding methods.

The most important components in DVC are side information generator and error correcting decoder. In this paper, we propose the method to improve the performance of side information. The proposed method updates the side information at the bitplane level on error correcting decoder of DVC decoder to enhance the accuracy of side information. Using quality improved side information we can reduce the amount of bits to decoding quantization index on error correction decoder of DVC decoder.

This paper is organized as follows. In section 2, we outline the proposed method. In section 3, we verify the performance of the proposed method using simulation. Finally in section 4, we conclude this paper.

2. Proposed Method

The error correction decoder starts decoding each transform coefficient band by bitplane level. The most significant bitplane (MSB) is decoded first and the least significant bitplane (LSB) is decoded lastly. We can improve the accuracy of side information by updating side information, after decoding each bitplane.

For example the quantization index of 2057 ("WZ" in Figure 1(a)) is 8 with 16 level (4-bit) uniform quantizer. The binary representation of quantization index 8 is "1000" ("QI: 8" in Figure 1(a)). Suppose that the corresponding side information value is 1849 (" SI" in Figure 1(a)), then binary representation of 1849 is "0111 0011 1001" and the quantization index of same 16 level quantizer of that side information value is 7 ("QI: 7" in Figure 1(a)). The first bit of decoded quantization index changes from "0" to "1" if error correction decoder corrects the error. Since the decoded bit is different from corresponding bit of side information, it is not reasonable to use the same side information value when decoding the next bitplane. In this case, it is appropriate that the side information is updated using previously decoded bit for decoding the subsequent bitplanes.

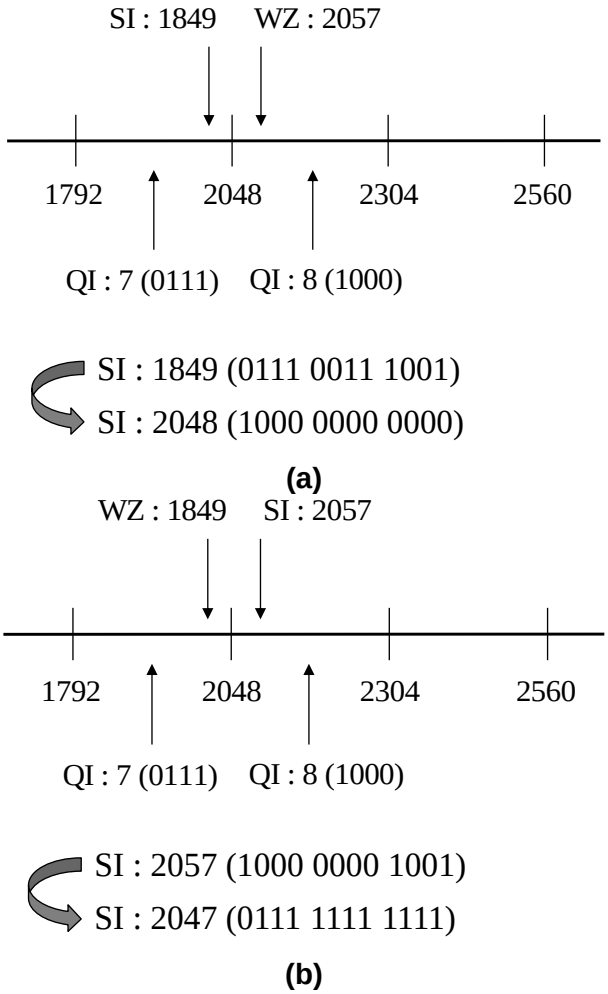


Figure 1. Side Information Update Process

The updated value of side information is decided by both the values of quantization index and its quantization interval. Suppose for example that the quantization index of side information is q and its certain bit is corrected, i.e., changed from "0" to "1" . Then the upper limit of the quantization interval of quantization index q-1 becomes the updated side information value. On the other way around, if a bit is corrected from "1" to "0", the updated side information value is the lower limit of the quantization interval corresponding to the quantization index q+1.

In above numerical example, a bit is corrected from "0" to "1". So the updated side information value is 2048 which is lower limit of quantization interval corresponding to quantization index 8. This process is illustrated Figure 1(a).

As another example, if the transform coefficient is 1849("WZ" in Figure 1(b)) then its quantization index is 7("QI: 7" in Figure 1(b)). If the side information value is 2057("SI" in Figure 1(b)), then its quantization index is 8("QI: 8" in Figure 1(b)). If the first bit is corrected from "1" to "0", the side information is updated to 2047 which is upper bound of the 7-th quantization interval as depicted in Figure 1(b). When a bit is not changed after error correction decoding, original side information value is kept. The remaining bitplanes are decoded without modifying the value.

3. Experimental Results

We implemented our DVC codec in transform domain using MATLAB to test the performance of our methods. The test conditions are same as the Discover codec [5, 6] and test sequences are "Coastguard" and "Hall". The rate and distortion performance results of proposed methods are presented in Table 1 and Figure 2. We can reduce the amount of parity to decode quantization index using side information update method. As a result, RD curve moves toward left side. It means that our methods can improve rate and distortion performance of DVC codec.

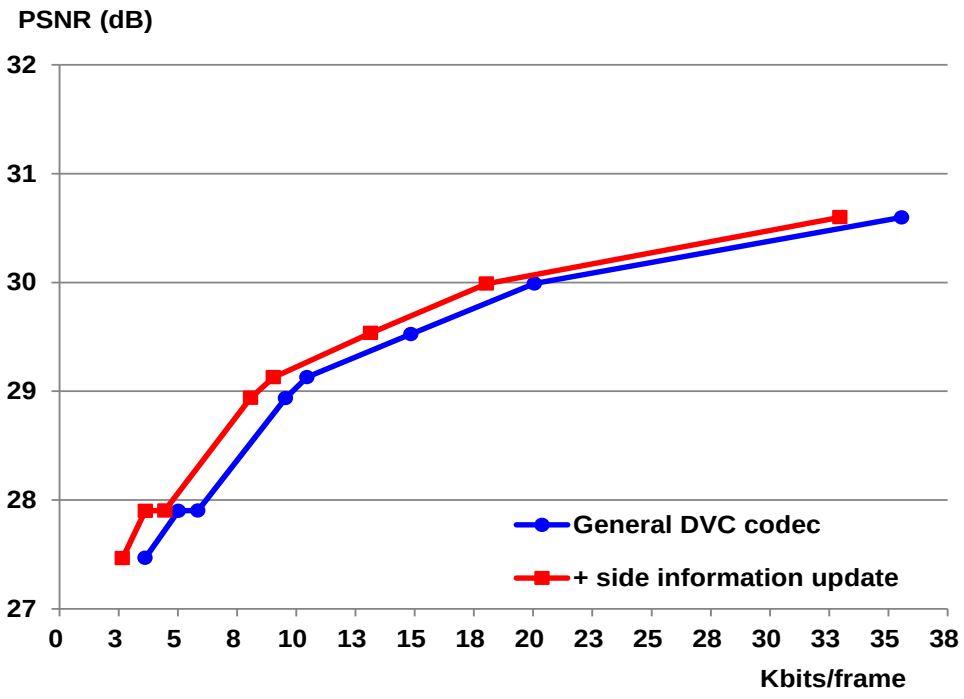
Table 1. Bits per Frame Comparison

(a) coastguard

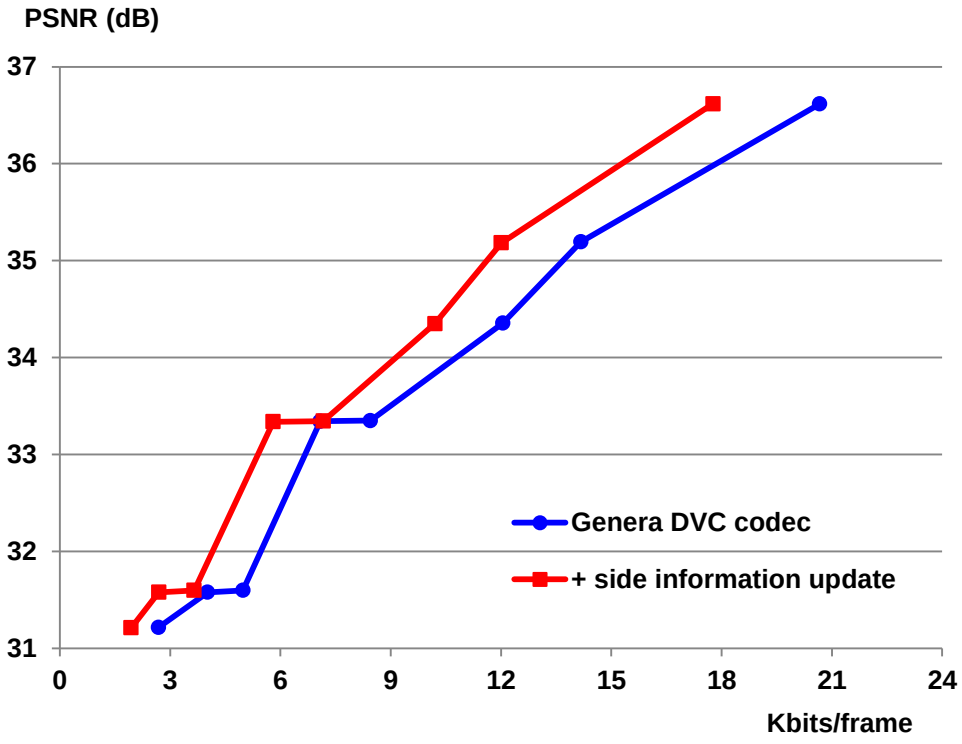
Quantization Matrix	General DVC Codec (bit/frame)	Apply Side Information Update Method (bit/frame)	Δ	Δ (%)
Q1	3618	2661	958	26.5
Q2	5024	3624	1400	27.9
Q3	5849	4449	1400	23.9
Q4	9549	8068	1481	15.5
Q5	10452	9036	1416	13.5
Q6	14843	13134	1709	11.5
Q7	20060	18035	2025	10.1
Q8	35569	32952	2617	7.4

(b) hall

Quantization Matrix	General DVC Codec (bit/frame)	Apply Side Information Update Method (bit/frame)	Δ	Δ(%)
Q1	2688	1939	749	27.9
Q2	4021	2694	1327	33.0
Q3	4981	3655	1327	26.6
Q4	7086	5803	1283	18.1
Q5	8451	7168	1283	15.2
Q6	12048	10205	1843	15.3
Q7	14172	12012	2160	15.2
Q8	20667	17768	2899	14.0



(a) Coastguard



(b) Hall

Figure 2. Rate and Distortion Curve of Proposed Method

4. Conclusions

In this paper we proposed side information update methods improving the performance of DVC codec. We can decrease the rate of codec by side information update method. We are expecting that overall DVC performance can be improved using proposed method.

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