Side Information Refinement and Update for Transform domain Distributed Video Coding

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Abstract. A new side information update and refinement methods for transform domain distributed video coding is proposed. The side information values are updated using both the values of quantization index and its quantization interval. It is refined at the end of each band decoding by conventional bi-directional motion estimation & compensation. Side information update reduces the amount of parities transmitted to decode quantization index. Side information refinement increases the PSNR of reconstructed pictures.

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 encoding techniques are not suitable for small multimedia. 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 [3, 4, 5]. DVC encoder performs only simple operation. DVC decoder, however, has to carry out most of the complex operations. In this paper, we propose two methods to improve the performance of side information at the bitplane and bandplane level.

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. Finally in section 4, we conclude this paper.

2 Proposed Methods

2.1 The Side Information Refinement

In the existing transform domain DVC codec, the side information, once generated, is used continuously until one frame decoding is completed. In our proposed method, the side information is newly generated after decoding each transform band, and it is subsequently utilized for the next transform band decoding.

The DVC's error correcting decoder corrects errors in each transform band of side information using the transmitted parity bits. Therefore error of decoded transform band is smaller than that of the uncorrected side information. The error corrected transform band replaces the corresponding transform band of side information and inverse transformed. After reconstructing pixel domain side information with this step, it is then used to generate new side information. Therefore newly generated side information has reduced distortion than the previous one. The new side information can be generated using conventional bi-directional motion estimation and compensation.

2.2 The Side Information Update 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 is 8 with 16 level (4-bit) uniform quantizer. The binary representation of quantization index 8 is "1000". Suppose that the corresponding side information value is 1849, 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. The first bit of decoded quantization index changes from "0" to "1" if error correction success. 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.

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.

3 Experimental Results

We implemented our DVC codec using MATLAB to test the performance of our methods. The test conditions are same as the Discover codec [5] and test sequences are “Coastguard” and “Hall”. The rate and distortion performance results of proposed methods are presented in Fig. 2. We can reduce the amount of parity to decode quantization index using side information update method. Furthermore the PSNR of final decoded sequences are improved by side information refinement method. As a result, RD curve moves toward the upper left side. It means that our methods can improve RD performance of DVC codec.

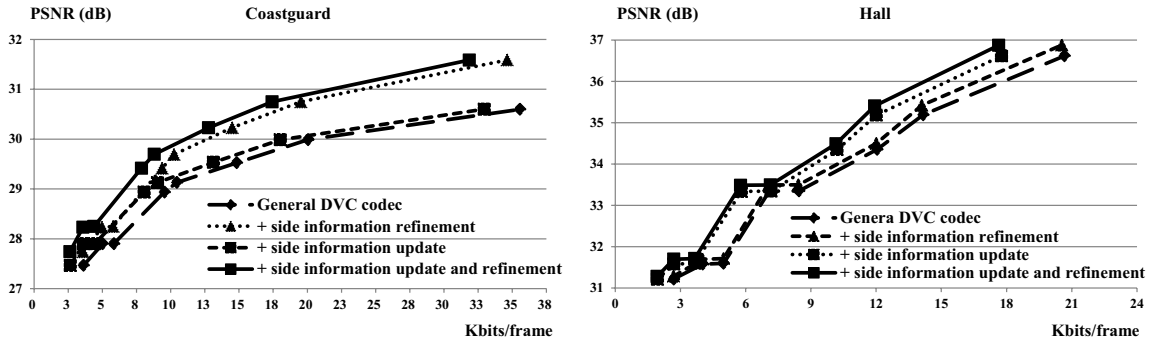

Fig. 2. Rate and distortion performance of proposed methods.

4 Conclusions

In this paper we proposed side information refinement and update methods improving the performance of DVC codec. The PSNR of final decoded sequences is increased by side information refinement method. And we can decrease the rate of codec by side information update method. We are expecting that overall DVC performance can be improved using proposed methods.

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