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CODING EFFICIENCY DISCUSSION FOR CAUSAL AND NON CAUSAL METHOD

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ABSTRACT

In this paper, we discuss coding efficiency for 3 kinds of coding method: H.264, HEVC, and non-causal prediction based coding method. The efficiency of these methods is examined. As these are hybrid-coding tools, both the prediction and transform-quantization parts are compared. According to the examine results, non-causal based coding shows enormous potentiality and wide application prospect.

1. INTRODUCTION

Recent years, the increasing demand for applications for ultra-high definition television (UHDTV) has led to the emerging video coding standard, High Efficiency Video Coding (HEVC[1)]), which was standardized in 2013. Compared to Advanced Video coding (AVC), HEVC can achieve double the compression ratio for the same video quality. In these coding standards, the Directional Spatial Intra Prediction, one kind of Causal Prediction (CP), achieves a significant improvement over the transform-domain prediction found in H.263+ and MPEG-4 Visual. However, there are some drawbacks of intra CP, namely: 1) they impose an arbitrary and artificial directionality on a decoded image. 2) Along with the distance between current and reference sample, the accuracy of CP will become increasingly worse.

To address these problems, NCP (non-causal prediction) was proposed2). It obtains a prediction of the current pixel from the nearest neighboring pixels. A representation of NCP model, which allows the use of Kalman-Bucy-type recursive algorithm, was proposed 3, 4). However, as this method is not based on pixel blocks but the entire image, real-time image coding processing is very difficult. Meanwhile, many block-based NCP coding schemes have been proposed. Hatori et al. proposed a coding scheme based on NCP and OQS (Optimal Quantization Scheme5)). This paper will show the prediction and quantization error comparison results of AVC, HEVC and NCP + OQS (See Reference 5) coding scheme.

This paper is organized as follows. In Section 2, the experiment condition will be introduced. The results of comparison for prediction and quantization efficiency for these 3 coding tools will be shown in Section 3. Conclusion is given in Sections 4 finally.

2. CODING METHOD

Hybrid encoding is a well-known coding technique in video compression systems. Almost all of hybrid encoding is the combination of Causal-Prediction Coding (CPC) and Orthogonal Transform Coding (OTC), which is well known as DPCM. In this paper, we will show the luma samples prediction and transform coding efficiency of AVC, HEVC and NCP+OQS method respectively.

2.1. Prediction Coding

In AVC, intra prediction is always conducted in spatial domain. For luma samples, the prediction block may be formed for each 4x4 block (denoted as I4MB) or for an entire MB (denoted as I16MB). The 4x4 prediction is suitable for images with significant details. It supports 8 directional modes plus one DC mode. The I16MB prediction, which is well suited for smooth image areas, supports four prediction modes. For the chroma 8x8 block of an MB, it is always predicted using a similar prediction technique as for the I16MB prediction.

Since high-definition video has more complex and detailed texture, the accuracy of HEVC intra prediction has been significantly improved. HEVC designs 33 angular direction modes in addition to planar mode and DC mode. In the HM16.0 anchor, the PU (prediction unit) size ranges from 2x2 to 64x64, and a PU checks up to 35 prediction modes to derive the R-D optimal one.

In non-causal prediction pixels surrounding the pixel to be predicted are used. Not only the “past” pixels which in the top and left of the current one but also the “future” pixels which in the right and below location.

2.2. Transform Coding

In AVC, the prediction error residual block is partitioned into multiple square TBs (Transform blocks), supported 4x4, 8x8 and 16x16. The core transform matrices were derived by approximating scaled DCT basis functions, under considerations such as limiting the necessary dynamic range for transform computation and maximizing the precision and closeness to orthogonally when the matrix entries are specified as integer values. In HEVC, the square TB extended to 32x32 and also introduces DST core transform matrices. However, the usage of the DST type of transform is restricted to only 4x4 luma blocks. In NCP+OQS coding scheme, {DCT, DST, DWT, DHT}+{Zigzag, Horizontal, Vertical}+OQS transform coding is applied. DWT means Discrete Wavelet Transform and DHT means NO TRANSFORM, just quantization, for some TBs, which are suitable for frequency operation.

3. SIMULATION

In our experiment, four test video sequences with CIF resolution were served, obtained from YUV Video Sequences website [6]. The AVC and HEVC reference software are JM16.2 (encoder.cfg) and HM13.0 (encoder_randomaccess_main.cfg) respectively and with same POC (Picture Order count) (084213657), two intra frames and seven B frames. Hatori Lab. Team develops the NCP+OQS test model.

3.1. Predict Coding results

The prediction error test results are shown in Table I. As prediction error of AVC and HEVC are changed with different QP (Quantize step Parameter) while NCP is stable; we set QP 0 to obtain the relative small prediction error. Furthermore, the result is the average value of 9 frames.

Table I Test Results of Prediction error

Tools / Seq.	ENTROPY			PSNR		
	AVC	HEVC	NCP	AVC	HEVC	NCP
Bus	3.27	3.07	2.97	28.00	30.13	31.63
Foreman	2.53	2.46	2.22	33.6	36.01	37.78
Highway	2.69	2.27	2.23	35.91	38.05	38.18
Flower	2.88	2.79	2.73	30.94	31.52	32.34

3.2. Transform Coding results

The comparison results of error after transform coding based on the following conditions: HEVC selected QP 28, at this point; JM and NCP selected the similar entropy point to record the PSNR. The test results are shown in Fig.1.

4. CONCLUSION

In this paper, AVC, HEVC and NCP+OQS coding tools are compared with predict and transform coding module. In conclusion, NCP based coding scheme could achieve better prediction so obtain smaller error. Therefor, we should make more effort to develop this kind of coding scheme. Future work should set up a complete NCP based codec.

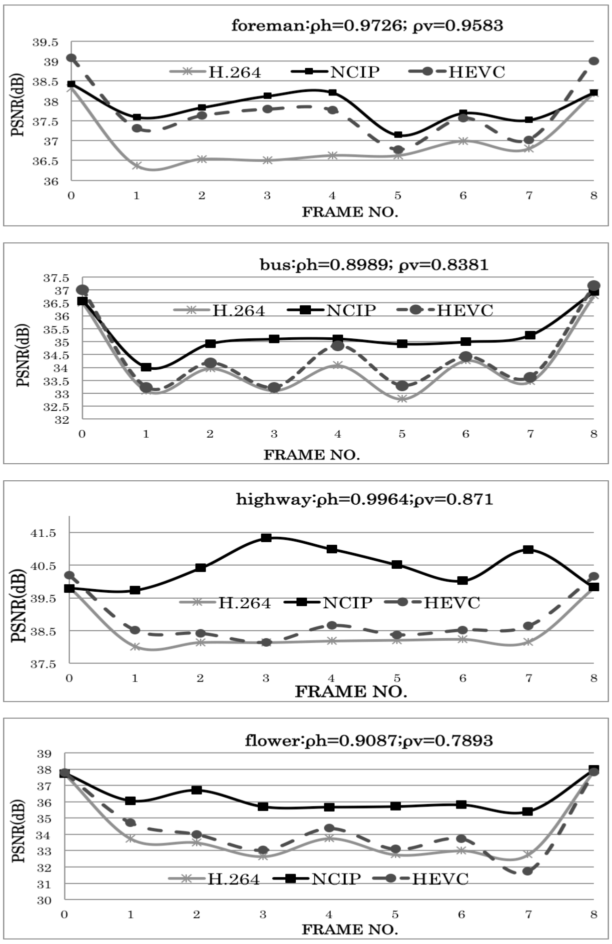

Fig.1 transform coding efficiency comparison

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