PalArch's Journal of Archaeology of Egypt / Egyptology

Improved Compression Efficiency in H.264/AVC using intra prediction modes for Information Hiding

Saurabh Anand

Department of Computer Engneering and Applications, GLA University, Mathura

saurabh.anand@gla.ac.in

Saurabh Anand, Improved Compression Efficiency in H.264/AVC using intra prediction modes for Information Hiding- Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(9). ISSN 1567-214x, Keywords: Compression, Lossy, Lossless

Abstract: Video compression is generally referred to minimizing the capacity of data which can be used to display video images effectively without affecting the perceptual quality. As it takes up so much of space, video needs to be compressed prior to being put on the network i.e. web. "Compressed" just signifies that the information is put up into a smaller space. In general, there are two basic types of compression - lossy and lossless. By producing small files in comparison with the original one, lossy compression compensates for the quality degradation. Lossless compression is what it exactly sounds similar to, a technique of compression where there is no loss of the information. This is a kind of technique which is not that useful as files frequently finish up of being the similar size as before compression they were. It may point useless, as the primary goal of compression of ours is reducing the file size. However, if file size reduction is not a matter of concern, then using lossless compression is a better option as this will lead to a perfect-quality picture.

1 Introduction

There are basically three kinds of frames namely I, P and B frames which we are considering in H.264/AVC i.e. our proposed technique for video compression. The I- frame is free of other frames as it involves intra-prediction. In this, "data is predicted based on adjacent blocks from the same frame". Predicted frame, which is a P frame on the other hand, is dependent on one or earlier frames and involves intra-prediction as well as motion estimation, that can be any frames out of I, P, or B frames[1]. "Temporal correlation between frames gets exploited by the motion estimation"[2]. It is the B frame (Bidirectional predicted frames) that depends on

earlier frames as well as future frames and there by using the motion estimation method which is bidirectional.

Compressed video can be effectively used to reduce the bandwidth which is required to pass on digital video via global broadcast, via satellite services or via cable. Some of the popular ITU-T compression standard are H.261, H.263 and H.264 standard" [2].

When the frames are passed quickly within the given frame rate which is sufficiently high (which is generally in the range 20-25 frames/second), then the viewers get perplexed that the motion is occurring [3]. Such video needs to get firstly compressed or encoded in an order that these can be stored or further transmitted as large video sequences [3].

2 Related Work

Earlier there have been schemes that divide the quantified DCT coefficients into two distinct clusters, covering clusters and stopping clusters[5].H.264/AVC involves two techniques of entropy- CABAC (Context Adaptive Binary Arithmetic Coding) or CAVLC (Context Adaptive Variable Length Coding) . In our proposed work we have employed CABAC, as it attains better contraction ratio in comparison with CAVLC [6]. In this transformation, only integer arithmetics are used without multiplications, with coefficients and scaling factors that allow 16-bit arithmetic computation [7]. Inter-prediction has played very important role for the compression improvement in H.264/AVC technique, Because this makes it possible to predict an MB from one or more MBs in other frames. Sizes that are allowed for prediction partitions are 16*16, 16*8, 8*16, 8*8, 8*4, 4*8 and 4*4, where each block has its own motion vector(s) [7]. Inter-block distortion is avoided and inner-block distortion is decreased [8]. A coding unit (CU), which is a motion-homogeneous block, is first tested in the HEVC encoding procedure based on analysis of the decoded information from the H.264 / AVC bit stream [9].

Intra- Prediction: Usually the first frame is not similar to the previous one in a new scene. That is the only reason frames are often referred to as I-frames not expected from previous or subsequent frames. Same is possible by the help of Intra-Prediction. P-frames makes use of both inter and intra prediction. H.264/AVC provided intra coding are -Intra 16x16, Intra 8x8 and Intra 4x4 [4] [10].

Once we obtain sixteen sub-blocks of 4 x 4, by dividing 16 x 16 pixel MB, then to each sub block, itra prediction is applied. The total modes for prediction are nine which are further choosed by the encoder independently for each sub-block [2]. Samples from the blocks to the west, northeast, and north are predicted using previously decoded samples. Intra 16x16 is best suited for coding frames with

Smooth tonal and color variations by predicting the entire MB [11]. For this prediction, there are four types of prediction modes.

– DC, plane, horizontal and vertical-prediction. Modes available for 4×4 blocks are very similar to horizontal, vertical and DC [10].

3 Proposed Work

The proposed method uses the nine intra prediction modes 4*4 for hiding information.

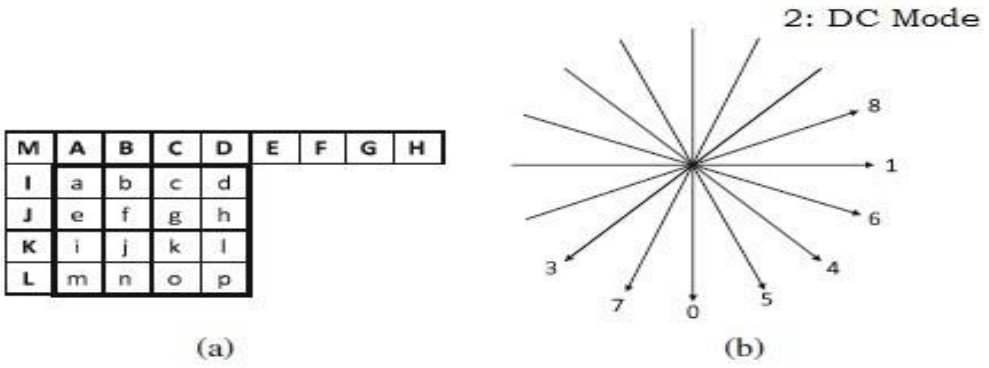
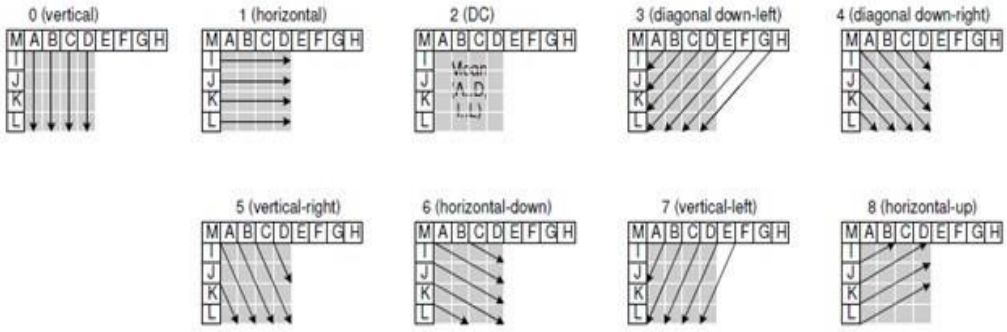


Figure 3. (a) Samples for Prediction –Labeling

(b) 4*4 Directions- I



ntra-Prediction

Figure 4. Intra Frame 4*4 Luminance Prediction Modes

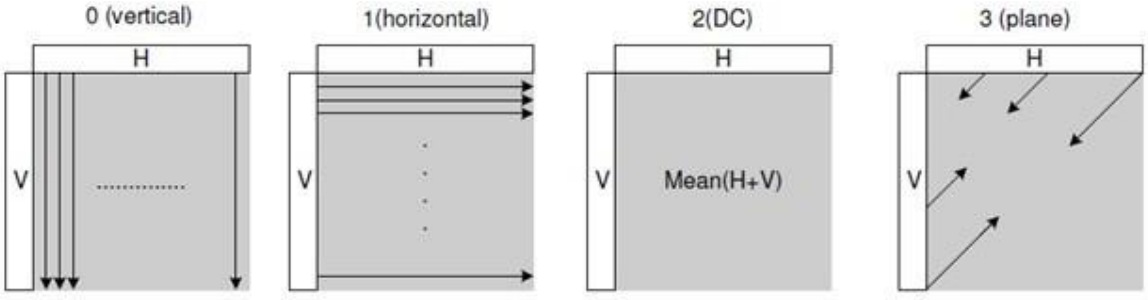


Figure 5. Intra Frame 16*16 Luminance Prediction Modes.

A through M here stands for previously decoded entries in adjoining blocks, H here represents the macroblock's 16 luminance values above V for the macroblock's 16 values to the left.

The "H.264 compression format" follows DCT-like transform coding and motion-compensated, here each image is partitioned into one or more slices for compression, and every slice consists of macro blocks and each macro block consists of "16 * 16 luma blocks" with consequent chroma samples. Nextly for prediction of movement, each macro block is divided into sub-macro block. Partition sizes allowed for prediction are 4* 4, 4* 8, 8* 4, 8* 8, 8* 16, 16* 8 and 16* 16. Now our video is integrated with the H.264/AVC encoding process since the procedures for movement estimation, intra-prediction and quantization have changed [4]. In order to reduce the prediction residuals "H.264/AVC" uses the inter prediction which needs to be further processed by entropy coding [11].

4 Results

In the proposed scheme, Luma and Chroma use F4 processing scheme to handle both intra and interresiduals. The advantage of using F4 technique is that the existence of hidden information may be revealed by careful steganalysis.

In order to attain the better safety in the F4 algorithm, some of the quantized coefficients may be left, as both the embedder and the detector know the rule. This is ultimately a trade-off between the security and payload of the hidden information.

Thus some bits can be saved in the current frame so that the subsequent frames can be allocated with lower QP values, and this frame will not only help preserve the frame information but will also produce more non-zero indices to increase the payload of hidden data[12]. The standard feature of rate distortion (R-D) doesn't take into account the mechanism of nonlinear human perception [13].

H.264/AVC offers advantages of using four 16 * 16 or nine 4 * 4 intra-predictive modes that can be added to the luma whereas four 8 * 8 chroma predictive modes. For our proposed work we use only the nine intra-prediction modes 4 * 4 for hiding information [4].

5 Conclusion and Future Work

At the last, with the aid of PSNR (Peak-Signal-To-Noise Ratio), we equate the qualities of stego images with those of the cover images. The PSNR equation reads as:-

$$PSNR = 10 * \log*((255)^2/MSE)\ dB \quad (1)$$

Where, for Mean Square Error, MSE stands. Picture quality is directly proportional to the PSNR value, and PSNR is exactly inverse in proportion to the MSE. The higher the PSNR value, the lower the MSE value. As a result, quality of stego images will be improved with the lowering of MSE values. This work still has some open ended questions; what can we say about the security of the data? We may wish to encrypt the data[14]. Research can be done towards that. Compression and embedding always come with a challenge how much data can be embedded without compromising on quality. We may also look upon the fact of improving the embedding speed alongwith the proposed work in this article [15]

References

1) Wang HX, Li YN, Lu ZM, Sun SH, "Compressed domain video watermarking in motion vector" Knowledge-based intelligent information and engineering systems. Springer, NewYork, pp 580–586, 2005

2) Po-Chyi Su , Ming-Tse Lu , Ching-Yu Wu, " A practical design of high-volume Steganography in digital video files", Published online: 19 April 2011 © Springer Science Business Media, LLC 2011

3) Spyridon K. Kapotas, Eleni E. Varsaki and Athanassios N. Skodras, "Data Hiding in H.264 Encoded Video Sequence".

4) Hongliu Zhu, Rangding Wang, Dawen Xu and Xingxing Zhou, "Information Hiding Algorithm for H.264 Based on the prediction difference of Intra_4×4", 2010 3rd International Congress on Image and Signal Processing (CISP2010)

5) Nguyen DC, Nguyen TS, Hsu FR, Hsien HY. A novel steganography scheme for video H. 264/AVC without distortion drift. Multimedia Tools and Applications. 2019 Jun 30;78(12):16033-52

6) Li, Xiaoni, Hexin Chen, Dazhong Wang, Tian Liu, and Gang Hou. "Data hiding in encoded video sequences based on H. 264." In *2010 3rd International Conference on Computer Science and Information Technology*, vol. 6, pp. 121-125. IEEE,

2010.

7) Min Wu, *Member, IEEE*, Heather Yu, *Associate Member, IEEE*, and Bede Liu, *Fellow, IEEE,"* Data Hiding in Image and Video: Part II—Designs and Applications*",* IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 12, NO. 6, JUNE 2003

8) Xue Y, Zhou J, Zeng H, Zhong P, Wen J. An adaptive steganographic scheme for H. 264/AVC video with distortion optimization. Signal Processing: Image Communication. 2019 Aug 1;76:22-30.

9) Yuan H, Guo C, Liu J, Wang X, Kwong S. Motion-homogeneous-based fast transcoding method from H. 264/AVC to HEVC. IEEE Transactions on Multimedia. 2017 Feb 15;19(7):1416-30.

10) YunXia Liu, Zhitang Li and Xiaojing Ma," Reversible Data Hiding Scheme Based On H.264/AVC without Distortion Drift", JOURNAL OF SOFTWARE, VOL. 7, NO. 5, MAY 2012.

11) Mohanapriya, "Design and Implementation of Steganography Along with Secured Message Services in Mobile Phones," *IJAETAE*, ISSN 2250-2459, Vol. 2, Issue 5, May 2012.

12) Min Wu, *Member*, *IEEE*, and Bede Liu*, Fellow, IEEE, "*Data Hiding in Image and Video: Part I—Fundamental Issues and Solutions*",* IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 12, NO. 6, JUNE 2003

13) Wang H, Gan W, Hu S, Lin JY, Jin L, Song L, Wang P, Katsavounidis I, Aaron A, Kuo CC. MCL-JCV: a JND-based H. 264/AVC video quality assessment dataset. In2016 IEEE International Conference on Image Processing (ICIP) 2016 Sep 25 (pp. 1509-1513). IEEE.

14) Tabash FK, Izharuddin M, Tabash MI. Encryption techniques for H. 264/AVC videos: A literature review. Journal of information security and applications. 2019 Apr 1;45:20-34.

15) An K, Lu Z, Yu F, Luo X. A Fast Data Hiding Algorithm for H. 264/AVC Video in Bitstream Domain. InInternational Conference on Genetic and Evolutionary Computing 2019 Nov 1 (pp. 237-244). Springer, Singapore.