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SELECTIVE MODE DECISION INTRA PREDICTION FOR H.264/ MPEG-4 AVC ENCODER

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Abstract: H.264 is the latest video coding standard, which is also known as MPEG-4 Part 10, or MPEG-4 AVC (Advanced Video Coding). It was published in early 2003 by the ITU-T Video Coding Experts Group (VCEG), together with the Moving Picture Experts Group (MPEG).The main goals of the H.264/AVC standardization is to enhance compression performance and to provide a "network friendly" video representation addressing "conversational" (video telephony) and "non conversational" (storage, broadcast, or streaming) applications. For the transmission of standard definition (SD) and high definition (HD) TV signals over satellite, cable and terrestrial emission and the storage of high-quality SD video signals onto DVDs require a higher coding efficiency which can be offered by H.264/AVC standard, but this comes at the cost of veryhigh computational complexity.H.264 is reportedly able to achieve high coding efficiency with the reduction of bit rate more than 50% in average.

A significant improvement in the rate-distortion has been achieved by H.264 in comparison to previously existing standards(MPEG-1, MPEG-2...). HEVC makes use of prediction to exploit redundancies in the signal and therefore achieve high compression efficiency. In particular, the Intra frame prediction block consists of predicting a block in the current frame using the reference information from neighboring blocks in the same frame. It supports 9 different modes based on directions. The objectiveis to improve Intra frame prediction block, with the goal of drastically reducing computational complexity and at the same time achieving comparable compression efficiency as conventional HEVC.

Keywords - High Efficiency Video Coding, Video Coding, Intra Frame Prediction, Advanced Video Coding, Moving Picture Expert Group, Prediction Block.

I. INTRODUCTION

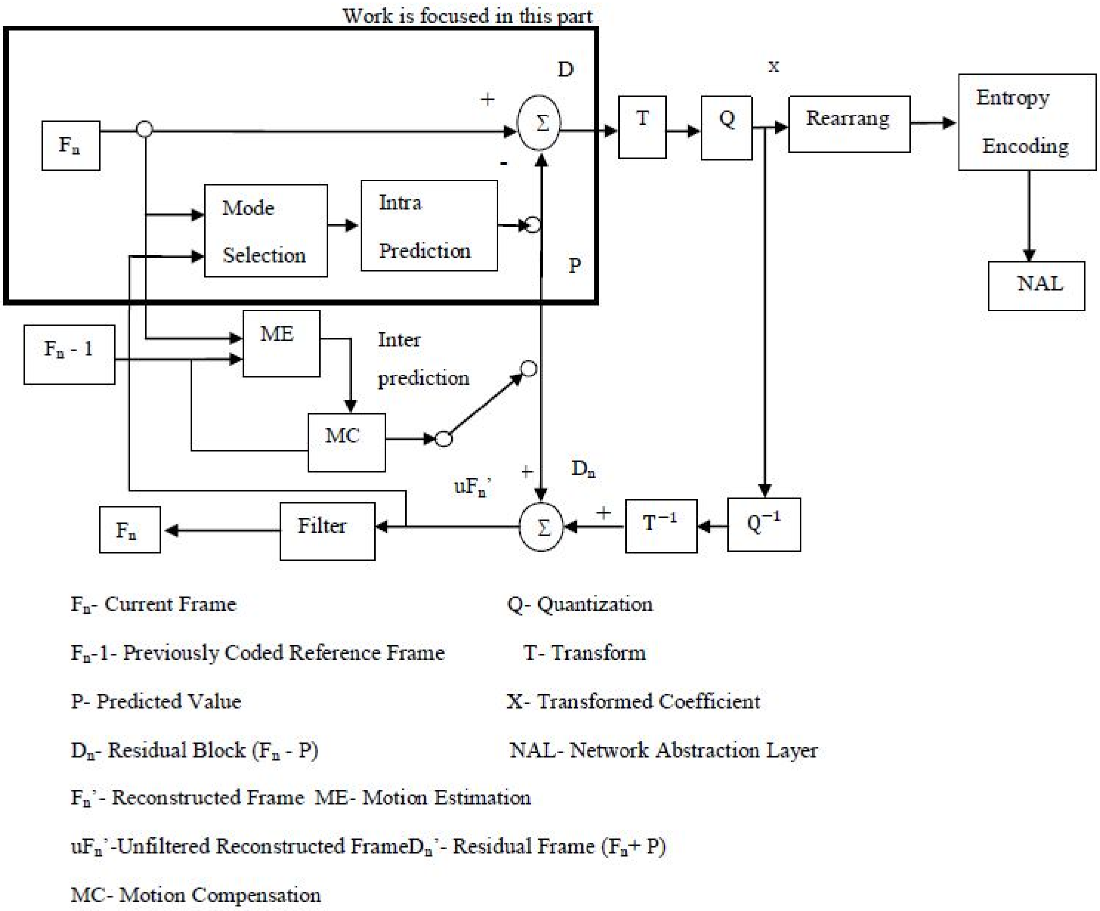
Transmission of video data in network environments, corresponding to Wi-Fi and internet in real time, is a difficult challenge, as it requires network friendly design and excessive compression. Today the video content providers face the challenges in providing their contents in a myriad of codec efficiency and high resolution due to rapid rise in internet and huge demands of mobile videos. The coding standard H.264/AVC specifies the decoding process and the bit stream syntax of the compressed video. The encoding process or how to produce the compressed video complying with the standard is not standardized. This provides a scope for the innovation in the development of the encoding algorithm. H.264 [1-10] is an industry standard for video compression, the process of converting digital video into a format that takes up less capacity when it is stored or transmitted. It is a video compression standard whose format is most commonly used for recording, compression and the distribution of video contents. The intention is to provide good video quality with lower bit rates (probably half of the bit rate) in comparison to MPEG-1, MPEG-2 and other previous standards.H.264 offers a significant performance improvement over previous video coding standards in terms of better peak signal to noise ratio and visual quality of variable block sizes for motion compensation, multiple reference frames, integer transform, deblocking filter, and Context Adaptive Variable Length Coding (CAVLC).

The job of the encoder or compressor is to encode or compress the source video signal into a coded bit streams. To achieve the data compression, video encoder takes advantage of the fact of having a large amount redundancy in temporal domain (inter-frame correlation) and spatial domain (intra-frame correlation). Redundancy refers to that part of the video signal when the message has predictable and redundant parts which do not provide new information but instead "repeat" some of the information already contained in previous parts. Compression of data significantly can be achieved by removing the redundant information in different domains. There are two types of redundancy i.e. spatial redundancy and temporal redundancy.

Depending on these two redundancies, there are two types of prediction in H.264/AVC i.e. Intra prediction and Inter prediction. Inter frame Prediction or Motion Estimation (ME) or Motion compensation (MC) is implemented by identifying and eliminating the temporal redundancies which exist between the consecutive individual frames. An Inter coded frame is divided into blocks known as macro block of sizes (16×16, 8×8, 16×8 and 8×16) that attempt to contain and isolate motion. After that the raw pixel values of each block are not encoded directly. The encoder searches a block similar to the one which is currently encoded. This prediction depends on the previous and future frames.

The H.264/AVC implements multiple directional intra prediction modes (9 modes for luminance 4×4 block type, 4 modes for luminance 16×16 block types, 4 modes chrominance 8×8 block type) by exploiting spatial redundancy for which the encoding in H.264 has improved. This advantage in H.264 makes it an attractive choice for the image and video compression. In Intra mode prediction of the video the current macro block (i.e. 16×16 pixel blocks) is predicted from the previously encoded neighboring macro block (MB) of the same video frame. Therefore in Intra prediction, an Intra –frame with all intra MB does not depend on any other video frames and these can be decoded independently. The mode–decisions are performed by brute force approach i.e. for each block size and each prediction direction the SAD(Sum of Absolute Difference) or RD(Rate-Distortion) cost is calculated. The particular mode which incurs minimum SAD cost is selected for encoding/transcoding. We want to simplify the prediction of the macro block which must not be computationally expensive for the real time applications. If a block or macro block is encoded in intra mode, a prediction block is formed based on previously encoded and reconstructed (but un-filtered) blocks. This prediction block P is subtracted from the current block prior to encoding. In H.264/AVC Intra prediction is performed at two levels hierarchical .i.e. for luminance and chrominance samples. For coding the luminance component, one 16 × 16 macro block may be predicted as a whole using four Intra_16 × 16 modes or each 4 × 4 sub block of 16 × 16 macro block may be predicted individually using a total of nine possible Intra_4 × 4 modes.

II. OVERVIEW OF INTRA PREDICTION FOR H.264/ MPEG-4 AVC



2.1. Block Diagram of Encoder of H.264/ MPEG-4 AVC

Fig. 2.1 represents the block diagram of encoder of H.264/AVC. The input frame F_n is processed in unit of macro block. The encoder can use two ways of prediction. They are Intra frame prediction and Inter frame prediction. If Intra frame prediction is adopted, the predicted value PRED (represented as P) is calculated from the previous macro block within current frame.Another way of prediction is Inter prediction where the current block is predicted from the reference frame (F_n-1) by block matching algorithm.

Then the residual block (Dn) can be calculated by subtracting predicted value (P) from the current block of frame (Fn). Then transformed coefficients X is calculated by passing the residual value (Dn) through the transform (T) and quantization (Q) blocks. And after entropy coding and adding some side information like motion vector and quantization parameter, the final stream can be transferred through NAL for transition or storage purpose.

To provide the reference frame for further prediction, the encoder should have the ability to rebuilt or reconstruct the frame, which is called decoding. To get Dn’, the residual image can be inverse quantized and inverse transformed. Then the unfiltered frame uFn’ can be obtained by adding Dn’ with p. After some noise removing, we can get the rebuilt frame **(**Fn’) which can be used as reference for further prediction [6-7].

2.2.4x4 luma prediction modes

Fig.2.1 shows a luminance macroblock in frame and a 4x4 luminance block that is required to be predicted. The samples above and to the left have previously been encoded and reconstructed and are therefore available in the encoder and decoder to form a prediction reference. The prediction block P is calculated based on the samples labeled A-M in Fig. 2.2, as follows. Note that in some cases, not all of the samples A-M are available within the current slice: in order to preserve independent decoding of slices, only samples within the current slice are available for prediction. The arrows in Fig. 2.3 indicate the direction of prediction in each mode. For modes 3- 8, the predicted samples are formed from a weighted average of the prediction samples A-L. The encoder may select the prediction mode for each block thatminimizes the residual between P and the block to be encoded. Then transform, quantization and entropy coding are applied respectively.The 9 modes are: vertical, horizontal, DC, diagonal down-left, diagonal down-right, vertical-right, horizontal-down, vertical-left, horizontal-up depending on the angle of orientations as shown in table 2.1.

M	A	B	C	D	E	F	G	H
I	a	b	c	d				
J	e	f	g	h				
K	i	j	k	l				
L	m	n	o	p				

Fig. 2.2: Labeling of prediction samples (4x4)

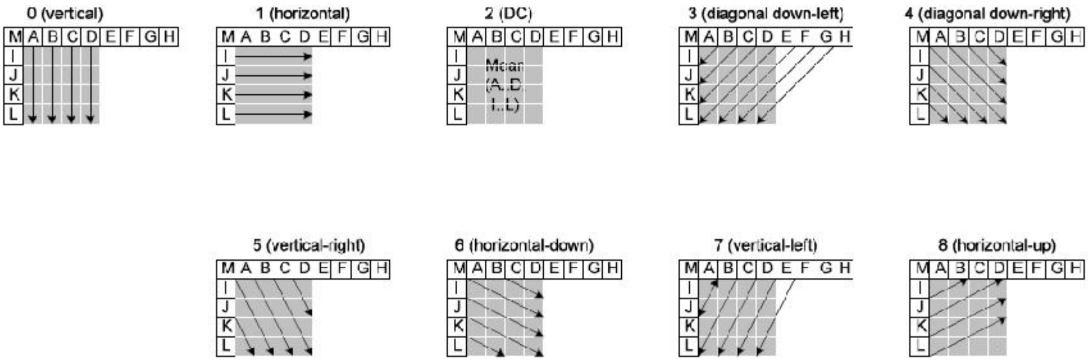


Fig. 2.3: 4x4 luminance9 predictionmodes

III. RESULTS AND DISCUSSION

The original image as shown in Fig 3.1 is cameraman.tif shown below of 256 × 256 size

Fig 3.1: Original Image

The 9 prediction modes (0-8) are applied on the image for the 4x4 block shown in Fig. 2.3. Fig.3.2 shows the prediction block P created by each of the predictions using MATLAB.

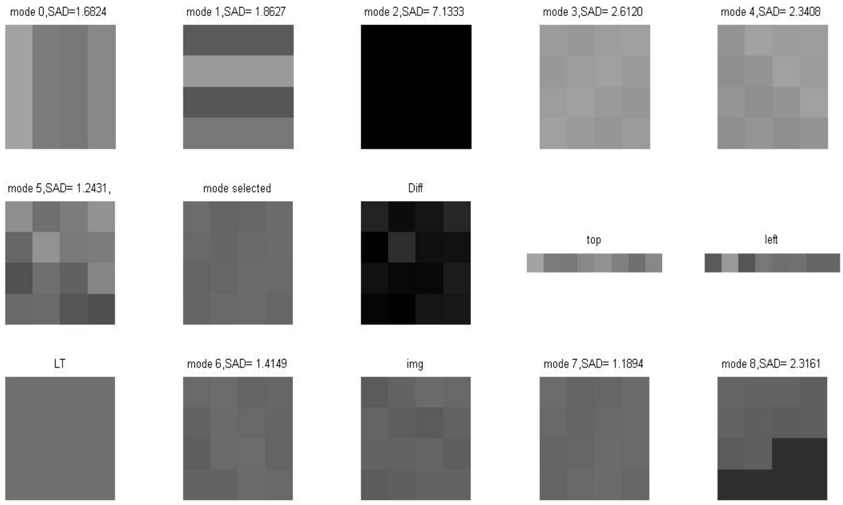


Fig. 3.2: SAD value for 9 modes

CONCLUSIONS

By using the Intra prediction algorithm for 9 modes the SAD value is calculated.For that an image of size 256 x 256 has taken. Sum of Absolute Errors (SAE) or Sum of Absolute Difference (SAD) for each prediction indicates the magnitude of the prediction error.By comparing the sum of absolute differences (SAD) of 9 modes, mode 7(Vertical- left prediction) has been selected by the encoder of H.264/ MPEG-4 AVC for this image shown in Fig. 3.1 as it has minimum SAD i.e. 1.1894.

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