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Efficient Mode Selection Based on Quality of Experience Estimation

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Abstract— A new video coding standard H.264/AVC has been recently developed and standardised, which represents a number of advances in standard video coding efficiency and flexibility and is replaced the existing standards such as H.263 and MPEG-1/2/4. In this project we present an efficient algorithm for selecting the best possible Mode according to locally computed Quality of Experience(QoE) characteristics.

Keywords— Quality of Experience, Mean Opinion Score, H.264

Introduction

H.264 is a new international video coding standard of ITU-T and jointly made by ITU-T Video Coding Experts Group (VCEG) and ISO/IEC MPEG Video Group, named as Joint Video Team (JVT). The goals of this standardization effort were enhanced compression efficiency, network friendly video representation for interactive (video telephony) and non-interactive applications (broadcast, streaming, storage, video on demand). The H.264/AVC video coding standard can deliver significantly improved compression efficiency compared with previous standards. Due to this improved compression efficiency and increased flexibility of coding and transmission, H.264 has the potential to enable new services over different networks. In this paper we present a Fast Mode Selection Algorithm based on user perspective metric called Quality of Experience (QoE).

Inter Prediction:

Inter prediction creates a prediction model from one or more previously encoded video frames. The model is formed by shifting samples in the reference frame(s) (motion compensated prediction). The AVC CODEC uses block-based motion compensation, the same principle adopted by every major coding standard since H.261. Important differences from earlier standards include the support for a range of block sizes (down to 4x4) and "ne sub-pixel motion vectors (1/4 pixel in the luma component).

AVC supports motion compensation block sizes ranging from 16x16 to 4x4 luminance samples with manyoptions between the two. The luminance component of each macroblock (16x16 samples) may be split-up in 4 ways as shown in Figure 21: 16x16, 16x8, 8x16 or 8x8. Each of the sub-divided regions is a macroblock partition. If the 8x8 mode is chosen, each of the four 8x8 macroblock partitions within the macroblock may be split in a further 4 ways as shown in Figure 22: 8x8, 8x4, 4x8 or 4x4 (known as macroblock sub-partitions). These partitions and sub-partitions give rise to a large number of possible combinations within each macroblock. This method of partitioning macroblocks into motion compensated sub-blocks of varying size is known as **tree structured motion compensation.**

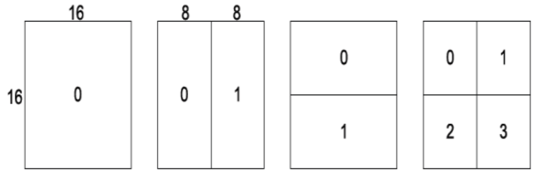


Fig: Macroblock partitions 16x16,8x16,16x8 8x8

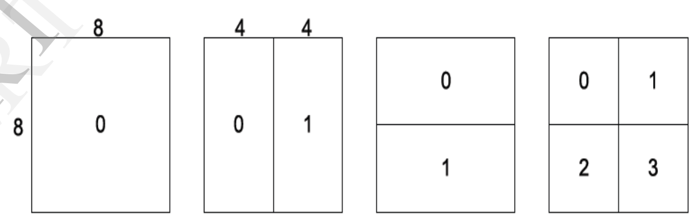


Fig: Macroblock-sub Partitions: 8x8, 4x8, 8x4, And 4x4

Quality of Experience (QoE):

QoE requirements define the overall, subjective performance at the services level from the perspective of the end user. The establishment of consistent, baseline quality of experience for end users and corresponding objective engineering targets is critical to the market successof broadband service offerings. As it is typically the viewer who judges video quality, the subjective measurement of mean opinion score (MOS) is considered to be an accurate way to determine the perceived video quality of compressed video. However, evaluating MOS is expensive in terms of time and resources and cannot be calculated automatically within real-time video applications. Hence several objective assessment methods have been developed to automatically predict the subjective results based on video content and the characteristics of the human visual system. A 5-grade discrete scale ranging from 0 to 1 was used to rate the quality of the test video sequences where 0=bad, 0.25=poor, 0.5=fair, 0.75=good and 1=excellent.

MOS	Quality	Impairment
5	Excellent	Imperceptible
4	Good	Perceptible but not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

A Fast Mode Selection Algorithm based on Quality of Experience Estimation

The mode selection process in block-based video encoders involves minimising the rate-distortion cost function J=D+ λ R where λ is the Lagrange multiplier, R is the rate and D is the SSD between original and reconstructed video data. MOSp-based mode selection would involve integrating the MOSp metric into the RD cost function to make the mode selection and choosing the best mode which minimises this cost function. A new MOSp-based mode selection model is Presented here.

The rate-distortion cost function used in the reference H264/AVC is:

$$J = D + \lambda \times R$$

Where λ is the Lagrange multiplier, R is the rate and D is the SSD between original and reconstructed video data. Integrating the MOSp metric into equation involves defining a new MOSp-based distortion measure and a new Lagrange multiplier. The new MOSp-based rate-distortion cost function model is given as:

$$J = D\text{mosp} + \lambda\text{mosp} \times R$$

where mosp *D* is MOSp-based distortion measure which replaces the SSD measure and *mosp* λ is the new Lagrange multiplier which must to be re-modelled. The Lagrange multiplier in the reference H264/AVC is calculated as a function of the Quantisation Parameter (QP) and has been modelled for SSD as the distortion metric. Therefore, changing SSD to *mosp D* will require re-modelling of the Lagrange multiplier to obtain λ mosp R is the total bits for coding a macroblock using the mode under test.

A distortion measure derived from the MOSp metric must be inversely related to the MOSp measure. Therefore, the MOSpbased distortion measure, *mosp D* is given as:

$$\text{Dmosp} = 1 - \text{MOSp}$$

The Mean Opinion Score (MOS) can be calculated from the set of formulas as shown below.

Video quality *Vq* is calculated using the video quality parameter *Vq* is expressed as

$$Vq = 1 + Icoding\left(-\frac{Pplv}{Dpplv}\right)$$

Where *Icoding* represents the basic video quality affected by the coding distortion under a combination of video bit rate (*BrV* [kbit/s]) and video frame rate (*FrV* [fps]), and the packet loss robustness factor *DPplV* expresses the degree of video quality robustness due to packet loss where *PplV* [%] represents the packet-loss rate.

The basic video quality affected by coding distortion Icoding in terms of Blockiness and Bluriness is expressed as:

$$Icoding = Iofr\ exp\left(-\frac{\ln(Frv) - \ln(Ofr))2}{2 * Dfrv\text{^}2}\right)x$$

Distortion in terms of Blockiness and Bluriness.

The *Ofr* is an optimal frame rate that maximizes the video quality at each video bit rate (*BrV*) and is expressed as:

Ofr =*v*1 +*v*2 **BrV* 1 <*Ofr* >30 *v*1 and *v*2 are constants

IOfr represents the maximum video quality at each video bit rate (*BrV*) and is expressed as:

$$Iofr = v3 - \frac{v3}{1 + \left(\frac{Brv}{v4}\right)\text{^}v5}$$

DFrV represents the degree of video quality robustness due to frame rate (*FrV*) and is expressed as:

DFrV +*v*6 +*v*7**BrV*, *v*6 and *v*7: constants

Mosp based Fast Mode Selection Algorithm:

1. For each Macroblock calculate the Activity using the following equation

$$A = \frac{1}{T} \times \sum_{i=1}^{T}\left(\frac{\sum_{i=1}^{P} Ai,j}{P}\right)$$

Where 'i' is the macroblock number and P is the total number of macroblocks in a video frame. 'j' is the frame number and T is the total number of frames in the video sequence

2 Calculate the Lagrangian Multiplier
λ=A*exp(B*QP).

A = (9.413E-009*Activity) + 1.152E-006
B = (-0.0003292*Activity) + 0.2685

3 Select a macroblock mode

4 Encode the Macroblock and calculate
$\text{Dmosp} = \text{mod}(1 - \text{MOSp})$

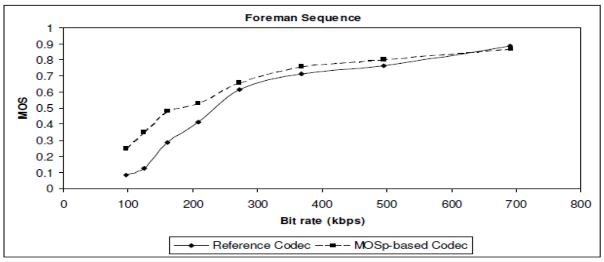
5 Compute the RD cost function.
J=Dmosp+ λmosp*R

6 Check if J < Jmin, where J min = minimum RD cost for all modes.

7 If J<Jmin, check if all modes have been evaluated. If NO, then update Jmin = J and go to step 2. If YES, then current mode is the best mode for encoding the macroblock.

Experimental Results:

To investigate if there is a gain in MOS using MOSp-based mode selection algorithm when compared with the reference H264 encoder, the results are presented as bitrate versus MOS graphs for each of the 3 test sequence. Each graph has two curves, one for each codec. These bitrate versus MOS graphs are presented in the below figures.



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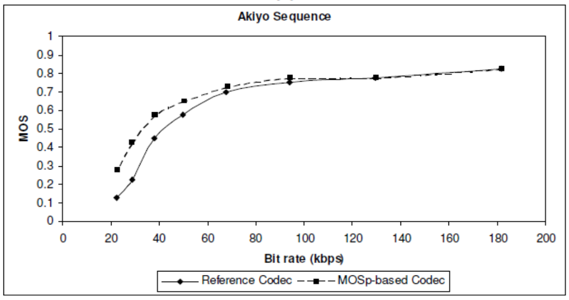

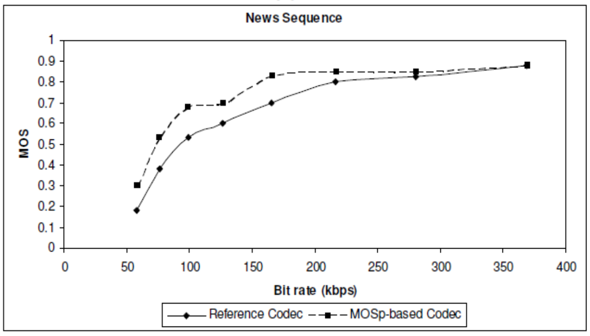

Below Table compares the coding performance of the two codecs and includes the following information

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1 Percentage gain (or loss) in visual quality for each sequence which is calculated as:

$$\Delta MOS = MOScodecB - MOScodecA$$

2 Percentage gain (or loss) in bit rate for each sequence calculated as:

$$\Delta Bitrate(\%) = \frac{BitratecodecB - BitratecodecA}{BitratecodecA} \times 100$$

Sequence	ΔBitrate (%)	ΔMOS
Foreman	0.06 to 0.83	-0.015 to 0.225
Akiyo	0.25 to 1.11	0 to 0.2
News	0.01 to 1.09	0.03 to 0.15

. CONCLUSION:

We propose a Fast Block mode selection algorithm based on Mean Opinion score. The algorithm uses objective method to arrive at subjective analysis of user perspective. Using this method we can rate the quality of video depending upon Blockiness in the video. We have achieved good results compared to other algorithms

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