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OPTIMAL BITRATE FOR THE SCALABLE HIGH EFFICIENCY VIDEO CODING (SHVC)

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ABSTRACT

The increasing diversity of video based services and the growing popularity of HD video and beyond-HD formats (e.g., 4k x 2k or 8k x4k resolution) are creating stronger needs for coding efficiency superior to H.264/MPEG-4 AVC capabilities [1]. The desire for higher quality and resolutions are being imposed by its users nowadays. As a result, MPEG and VCEG have formed a Joint Collaborative Team on Video Coding (JCT-VC) to develop a successor to H.264/MPEG-4 AVC. This standard is referred as High Efficiency Video Coding (HEVC) [2]. HEVC has been developed to address essentially all existing applications of H.264/MPEG-4 AVC and to achieve multiples goals, including coding efficiency, data loss resilience, as well as implementability using parallel processing architectures. Results show a reduction in bit rate requirements by half with similar subjective perceptual quality when compared with H.264/MPEG-4 AVC, at the expense of increased computational complexity. The first version of HEVC was completed in January 2013, and several revisions have been deployed since then. This paper is describing some research work based on the extension of HEVC, that of Scalable HEVC, in other words SHVC [3].

SHVC became the first scalable video coding standard that is built upon high-level syntax only (HLS-only) scalable coding framework. Empowered by efficient inter-layer reference picture processing modules, SHVC achieves high scalable coding efficiency without requiring any block-level coding logic changes to the single-layer HEVC cores. Given that SHVC is a finished process, this paper will focus on the scalable extension of HEVC standard and in particular on the partition of the total bit rate over all layers.

The objective of a video encoder is to generate the optimum perceptual video quality, or to minimize distortion, under a certain set of requirements such as channel bandwidth or storage limitations. General speaking, for a specific bit budget, the video encoder should optimally determine a set of the best quantization parameters by minimizing the value of the distortion, since the quantization parameter has a major role in the generation of bits and distortion. If a video sequence is encoded using all the different quantization parameters, then rate and quantization error can be obtained and it is possible to plot the rate-quantization (R-Q) or the distortion-quantization (D-Q) curves. R-Q and D-Q functions characterize the rate-distortion (R-D) behavior of the video encoding process. As far as we know, there is no investigation work in the literature related to the bitrate distribution between spatial resolution layers.

The following Table 1 shows our simulation results obtained from two video sequences, Old Town Cross and Crowd Run encoded in HEVC and SHVC. In both video sequences and for SHVC, the base layer is encoded with 1280x720 pixels and the enhancement layer with 1920x1080 pixels at 50 frames/s. In HEVC, both resolutions are encoded separately. SHVC by using the interlayer prediction achieves a bit reduction and time reduction of 28.7% and

33.6% without any significant loss in quality in comparison to HEVC in simulcast mode. It is clear that an optimal judgment must be carried out to distribute the total bitrate between the two layers. The optimal quantization pairs are (QP_{BL}, QP_{EL})={(20,32), (24,32), (28,32), (32,36), (36,32)}. In the final paper, we will determine the optimal bitrate in function of the optimal quantizer of the enhancement layer, QP_{EL}=32.

Table 1 - Coding performance between SHVC and HEVC

		Old Town Cross			Crowd Run		
QP BL	**QP EL**	**Bitrate reduction**	**Time reduction**	**PSNR EL gain (dB)**	**Bitrate reduction**	**Time reduction**	**PSNR EL gain (dB)**
20	20	7.2%	23.9%	-0.074	12.5%	19.9%	-0.058
20	24	12.4%	27.4%	0.061	25.1%	27.9%	-0.069
20	28	9.2%	25.3%	0.230	27.6%	36.2%	0.837
20	32	7.4%	26.9%	0.821	21.5%	38.9%	2.458
20	36	5.6%	24.8%	1.935	15.0%	37.1%	4.221
24	20	3.8%	24.1%	-0.034	7.3%	18.7%	0.001
24	24	8.1%	26.6%	0.017	16.8%	21.0%	-0.102
24	28	18.2%	27.9%	0.037	33.3%	34.5%	0.001
24	32	18.7%	30.8%	0.517	31.0%	40.3%	1.456
24	36	14.7%	27.7%	1.595	23.2%	39.1%	3.193
28	20	2.2%	23.7%	-0.017	3.7%	18.7%	-0.002
28	24	5.9%	25.6%	0.005	7.9%	19.0%	-0.009
28	28	15.8%	26.6%	-0.023	20.8%	22.6%	-0.175
28	32	27.4%	30.9%	0.116	39.3%	39.7%	0.094
28	36	26.1%	28.5%	1.021	34.5%	40.7%	1.712
32	20	1.0%	23.3%	-0.004	2.0%	18.9%	-0.005
32	24	4.1%	24.4%	-0.002	3.7%	19.0%	-0.007
32	28	10.5%	25.6%	-0.031	8.7%	19.6%	-0.025
32	32	23.2%	30.0%	-0.078	23.3%	24.5%	-0.200
32	36	34.3%	28.2%	0.227	43.7%	39.4%	0.068
36	20	0.4%	22.9%	-0.002	1.0%	19.2%	0.003
36	24	2.3%	24.1%	-0.001	1.7%	19.1%	-0.007
36	28	5.3%	24.8%	-0.026	4.0%	19.3%	-0.021
36	32	14.7%	29.7%	-0.081	9.9%	21.3%	-0.053
36	36	27.6%	27.1%	-0.155	24.8%	25.6%	-0.221

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