Performance evaluation of High Efficiency Video Coding (HEVC) test model HM-16.12 vs. HM-16.6

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Abstract— High Efficiency Video Coding (HEVC) as a standard introduced by ITU-T Video Coding Experts Group (VCEG) and ISO/IEC Moving Picture Experts Group (MPEG) was first approved in 2013 in the ITU-T as Recommendation H.265 and ISO/IEC as International Standard 23008-2. This standard offers a new degree of compression capability for a great variety of applications and recently, it has been extended in some important ways to broad scope. In an attempt to continue with an analysis performance of different versions of HM software test models in different environments, two models HM-16.12 and HM-16.6 are compared through three fundamental parameters: signal-to-noise ratio, bit rate and time saving, while two test sequences in different resolutions are processed. Beside objective results, subjective video assessments for all tested sequences are presented, too.

***Keywords*—**Bit-rate, encoding time saving, HEVC, signal to noise ratio.

I. Introduction

To meet the ultra-high-definition (HD) video compression demand, high efficiency video coding (HEVC) uses a hybrid coding scheme similar to that of H-264 [1], consisting of inter-and intra-frame prediction, transform units, an in-loop filter and entropy coding. Also, it displays an improvement over H.264 in several aspects, such as: large hierarchical units, advanced productions, simplified structure HEVC standard has been designed to address the existing applications of H.264/MPEG-4 AVC standard and to focus on two key issues: increased video resolution and increased use of parallel processing architectures [2]-[5]. Anyway, coding efficiency, ease of transport system integration, data loss resilience and implementation using parallel processing architectures remain goals for designing HEVC standard [6], [7].

This paper is organized as follows. After short background, performance evaluation of the HEVC test model HM-16.12 encoder vs. HM-16.6 is provided through experimental results and brief discussion. Three fundamental parameters such as: signal-to-noise ratio, bit rate and time saving will be taken into consideration in different environments.

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II. Background

In our previous work [8], it was indicated that HEVC standard HM-16.6 in low-delay configurations of encoder have numerous challenges, when signal-to-noise ratio, bit rate as well as encoding time saving are measured and analyzed in the case of different resolution test sequences and picture formats, i.e., IPPP vs. IBBB. Also, simulation results have shown differences in bit rate and encoding time saving, as well as small difference in SNR values for luma component of picture.

III. Simulation Results

Simulation results represent the continuation of our experimental work on performance evaluation for two versions of HM software test model in different conditions.

We evaluated the performance of the HEVC model HM-16.12 vs. model HM-16.12 [9], when encoder_lowdelay_main and encoder_lowdelay_P_main configurations were used. The system platform was the Intel(R) Core(TM) i3-2328M Processor of speed 2.2 GHz, 6 GB RAM, and Microsoft Windows 7 Professional. The HEVC software configurations were as follows: Main profile, two values of Levels: 4.0 and 5.0, P pictures, hierarchical B pictures, period of I-pictures: only first, Hadamard transform was used, MV (Motion Vectors) search range was 64, SAO (Sample Adaptive Offset), AMP (Asymmetric Motion Partitions) and RDOQ (Rate-Distortion-Optimized Quantization) were enabled, GOP (Group of Pictures) length 8 (4) in IBBB (IPPP) format was used. The QP (Quantization Parameter) used was 32.

All processed configurations are adopted to Main profile.

Experiments were carried out on the tested sequences with fix quantization parameter value QP=32. We chose QP=32 as value of the QP, because it is approximately average value in reference software setup configuration.

For the experiments two different test sequences are selected. The selected test sequences are in different resolution and frame rates. We used the first 50 frames of test sequences Traffic and Kimono1. The test sequence Traffic in resolution 2560x1600 pixels belongs to class A, while test sequence Kimono1 in Full High Definition (full HD) resolution

TABLE 1: EXPERIMENTAL RESULTS WHEN HM-16.12 IS COMPARED WITH HM-16.6 IN MAIN PROFILE AND DIFFERENT PICTURE FORMATS

Test sequences (resolution)	Profile	HM-16.6	HM-16.12	HM-16.12 vs HM-16.6	HM-16.6	HM-16.12	HM-16.12 vs HM-16.6	HM-16.6	HM-16.12	HM-16.12 vs HM-16.6
	Main	SNR-Y (dB)	SNR-Y (dB)	SNR-Y (dB)	Bit-rate (kbps)	Bit-rate (kbps)	Bit-rate (kbps)	Time saving (sec)	Time saving (sec)	Time saving (sec)
Traffic (2560x1600)	Lowdelay	36,05	32,17	**-10,76**	2448,58	19649,16	**87,54**	11328,50	17041,54	**33,52**
	Lowdelay_P	36,00	32,18	**-10,60**	2504,76	20120,58	**87,55**	7279,74	14080,44	**48,30**
Kimono1 (1920x1080)	Lowdelay	37,54	37,54	**0,00**	1635,71	1634,97	**-0,05**	7300,13	8439,25	**13,50**
	Lowdelay_P	37,38	37,37	**-0,02**	1707,93	1703,47	**-0,26**	5036,93	7432,07	**32,23**

(1920x1080 pixels) belongs to class B [4]. All the test videos are in YUV 4:2:0 format and progressive. Details about the test sequences and sequence classes that are used for the comparisons in the paper are summarized in [4].

Also, the SNR values of luma (Y) component of pictures are used. We measured SNR only for Y because human visual system is more sensitive to luma then to chroma components of pictures.

Comparisons with the case of exhaustive search were performed with respect to the change of Signal to Noise Ratio (SNR), the change of data bit-rate (Bit-rate), and the change of encoding time saving (Time), respectively.

Table 1 shows the performance and comparison of the reference codecs for hierarchical B pictures processing in the IBBB format in lowdelay configuration and for P pictures processing in the IPPP format in lowdelay_P configuration for QP=32, respectively, based on our simulation results.

For Kimono 1 test sequence there are small differences in SNR values for luma component of picture in the both tested configurations when the test model HM-16.12 is compared with HM-16.6. On the other hand, for Traffic test sequences there are approximately 11% differences in SNR values (denoted by „-”) for both tested configurations when two test models are compared.

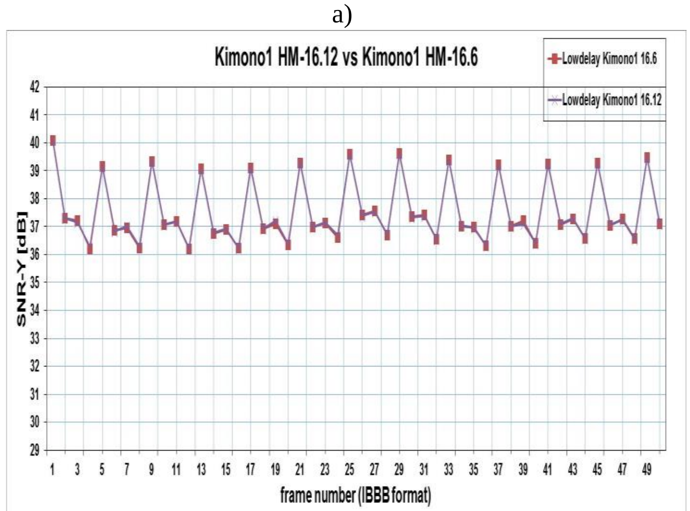
From bit rate point of view, for Kimono 1 test sequence there are very small differences in values in both lowdelay configurations when two test models are compared. On the other hand, for Traffic test sequences bits rate is decreased the little bit over 12 % in the test model HM-16.12 when the both tested configurations are compared.

Finally, for Kimono1 test sequence the encoding time saving is increased 13,5% for lowdelay and 32,2% for lowdelay_P when the test model HM-16.12 is compared with HM-16.6. Also, for Traffic test sequence the encoding time saving is increased 33,5% for lowdelay and 48,3% for lowdelay_P when the test model HM-16.12 is compared with HM-16.6.

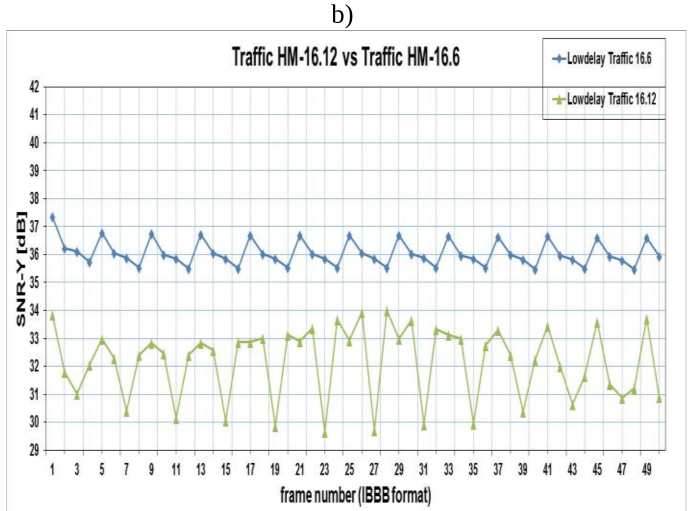
In Fig. 1 SNR curves are depicted for Kimono1 and Traffic test sequences for both test models in which the SNR-YUV is plotted as a function of the frame number for lowdelay configuration in IBBB picture format and for lowdelay_P configuration in IPPP picture format. Presented curves represent SNR for both tested models. Fig. 1 a and c SNR shows on objective way SNR small differences for Kimono1 processed test sequence between the HM-16.6 and the HM-16.12. On the other hand, Fig. 1 b and d SNR show obvious differences in values for Traffic test sequence.

In Fig. 2 bit-rate savings curves are depicted for both typical tested sequences. Fig. 2 represents the bit-rate differences between both HEVC HM tested model, tested configurations and picture formats (IPPP and IBBB) which have different bit-rate trends as it is shown in Table 1.

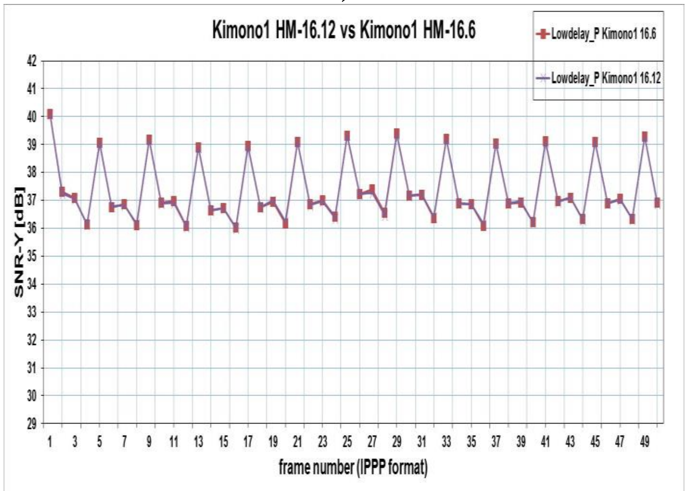
a)



b)



c)



d)

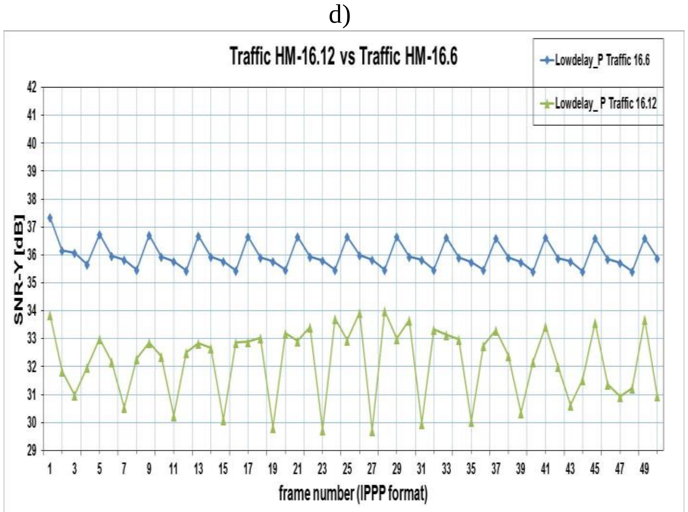
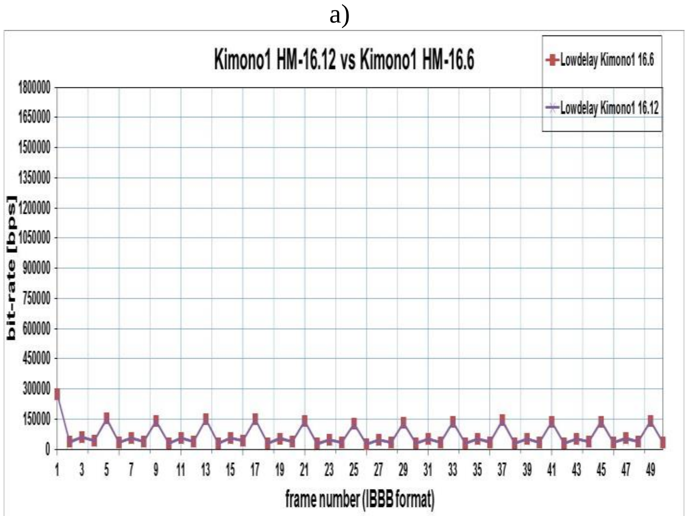
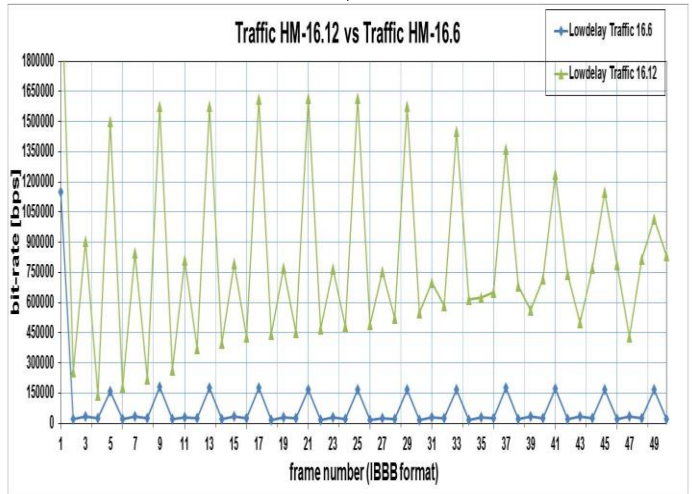


Fig. 1. SNR curves when in HM-16.6 and HM-16.12 reference software for Kimono1 and Traffic test sequences are compared in IBBB format and IPPP formats.

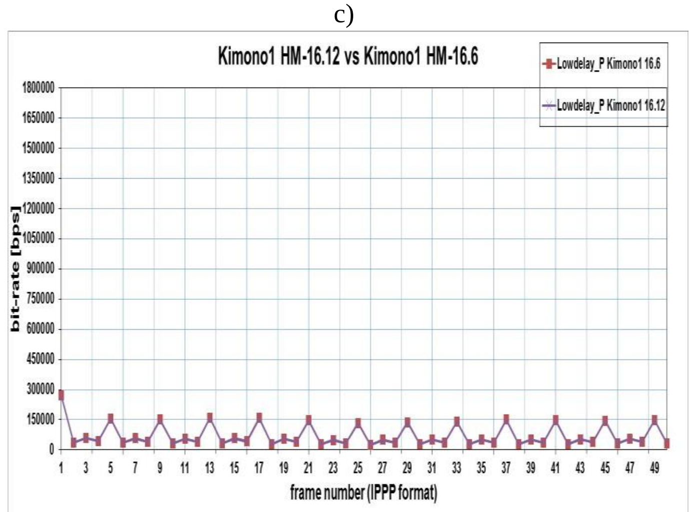
a)



b)



c)



d)

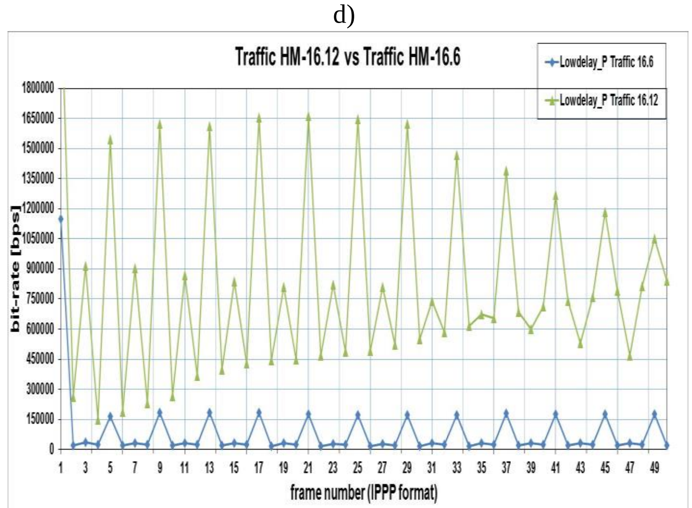


Fig. 2. Bit-rate curves when in HM-16.6 and HM-16.12 reference software's for Kimono1 and Traffic test sequences are compared in IBBB format and IPPP formats.

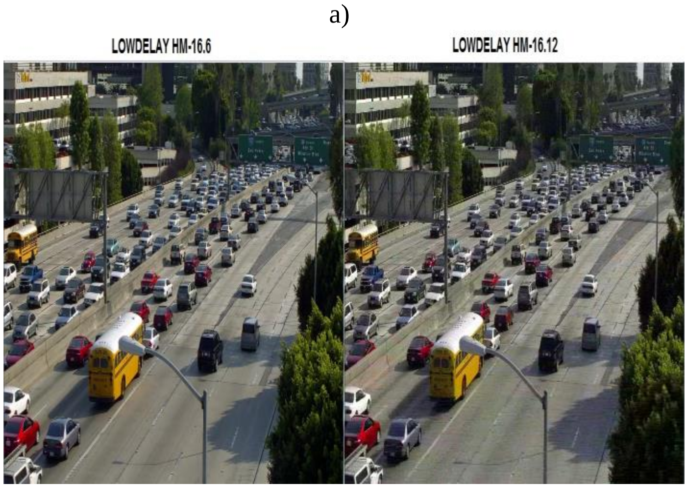
Beside objective analysis of the HEVC encoders for two different resolution test sequences, subjective video quality is analyzed, too.

a)

b)

Fig. 3. HEVC subjective video assessment for Kimono1 test sequence when in lowdelay configurations between HM-16.12 and HM-16.6 reference software's are compared.

a)



b)

Fig. 4. HEVC subjective video assessment for Traffic test sequence when in lowdelay configurations between HM-16.12 and HM-16.6 reference software's are compared.

Fig. 3 (a and b) and Fig. 4 (a and b) show HEVC HM-16.6 and HM-16.12 in both HEVC tested configurations and picture formats for subjective video assessment. All tested sequences are processed by YUV player, respectively. Subjective assessment results clearly indicate that there are small differences in term of SNR in Fig. 3. Also, there are some differences as shown in Fig. 4 in accordance with results in Table 1.

IV. Conclusion

The results presented in this paper indicate that HEVC standard HM-16.12 and HM-16.6 are compared in lowdelay configurations, when SNR, bit-rate and encoding time saving are measured for different resolution test sequences and picture formats (IPPP and IBBB). Simulations results have shown that for Kimono 1 test sequence there are small differences in SNR values for luma component of picture and bit rate, while encoding time saving is increase 13,5% and 32,2% depending on configurations. On the other hand, for Traffic test sequence there are approximately 11% differences in SNR values, while bits rate is decreased the little bit over 12 % and encoding time saving is increased 33,5% and 48,3% depending on configurations. Also, results of subjective video assessment for all tested sequences processed by YUV player are provided, when performance for HEVC HM-16.12 encoder are compared with HEVC HM-16.12 encoder.

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