PREDEFINED QUALITY PROFILES IN DIFFERENT VERSIONS OF HEVC ENCODER– INFLUENCE OF PC ARCHITECTURE OF PROCESSOR

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Abstract: This paper describes a coding efficiency of the High Efficiency Video Coding (HEVC) encoder with different predefined quality profiles. To increase the encoding speed of the video at the same bitrate we can use either other implementation of the encoder or we can set different predefined quality profiles. The x265 is the implementation of the coding standard HEVC. This article complements of our previous exploration of predefined x265 profiles. There is explored the influence of processor architecture and version of x265 implementation on the speed of encoding and on the performance of video quality.

Keywords: H.265, HEVC, x265, processor architecture, PSNR, SSIM, VQM

1. INTRODUCTION

Nowadays, customers' interest for video services in a high quality is increasing. It is necessary to use encoders with higher coding efficiency because the transmission bandwidth is limited. Advanced video codecs are more flexible but also more complexes and need more time to encode video. The H.265 encoder, known as High Efficiency Video Coding (HEVC), is used for IPTV Netflix and will be used in the upcoming 2nd generation Digital Video Broadcasting – Terrestrial (DVB-T2) standard. Real-time encoding of videos is necessary in various systems but it is not necessary in home conditions. Why examine predefined setting of HEVC encoder? If a compression of video needs five hours instead of one hour, it should be proved that such time consumption has significant effect on the final video quality. The video quality highly depends on encoders profiles [1]. Hence, unanswered questions are: What is the performance of the new version of encoder? Can the new processor architecture improve the speed of video encoding?

This paper is organized as follows. Brief description of the HEVC encoder, video sequences and objective video quality metrics are outlined in Section II. Results from objective metrics are evaluated, compared and discussed in Section III. Finally, Section IV concludes the paper.

2. ENCODED VIDEOS AND CODEC

2.1. CODEC HEVC AND ITS IMPLEMENTATIONS

The x265 is the most widespread implementation of HEVC encoder. It is often used to rip the movies from DVD or Blu-ray to the personal computer (PC). The HM is the reference implementation of HEVC for video encoding however, it is not often used (slow encoding). This is the main reason why x265 is prioritized implementation because speed of encoding is higher and its impact on overall video quality is negligible. This implementation is still under the research and its new releases are available in [3]. Parameters of the used HEVC codec implementations are in Table 1.

Implementation	x265	x265
Built date	24.1.2015	24.1.2014
Compiler	GCC 4.6.3	GCC 4.6.3
Encoder version	1.4	0.6

Table 1: Parameters of used HEVC codec

Parameters of predefined quality profiles of HEVC encoder are in Table 2. Our implementation is able to measure the time needed to encode video by itself. There were defined only bitrates and profiles without any other system parameter modification and without any tune of the encoder. Dispersion of the set bitrate was about 3 %. Such dispersion is sufficiently small.

Profile	Ultrafast	Superfast	Veryfast	Faster	Fast	Medium	Slow	Slower	Veryslow	Placebo
CTU	32	32	32	64	64	64	64	64	64	64
Bframes	4	4	4	4	4	4	4	8	8	8
RC	10	10	15	15	15	20	25	30	40	60
Refs	1	1	1	1	3	3	3	3	5	5
Me	dia	hex	hex	hex	hex	hex	star	star	star	star
Merange	25	44	57	57	57	57	57	57	57	92

Table 2: Parameters of predefined profiles for encoder x265 [1].

Name	CPU	Architecture	Core/Threat	Frequency	RAM	SP Flops
C2D	C2D-E6700	Conroe	2/2	2.66 GHz	4GB 800MHz	42,4 GFlops
i5	i5-3550	Ivy Bridge	4/4	3.3 GHz	8 GB 1600 MHz	220,7 GFlops
i7	i7-2600	Sandy Bridge	4/8	3.4 GHz	16GB 1333MHz	219,7 GFlops

Table 3: Parameters of used computers

Hardware parameters of used computers are in Table 3. Computer C2D is an old PC appropriate only for office work. Computers i5 and i7 are up to date average powerful PCs. Performance of all PC configurations was calculated by parameter FLOPs. FLOPS is an acronym for floating-point operations per second and it is a benchmark of computer performance. Single precision flops were measured. The performance of C2D computer is five times weaker than the performance of i5 and i7. Computer i5 is newer than i7 but i5 is for a common user while i7 has high-end performances.

2.2. USED VIDEOS

For a set of tested videos, it was necessary to choose various kinds of videos (see Figure 1). The experiment was performed on two uncompressed video clips in RAW format. Such short video sequences have various spatial and temporal indexes (SI and TI) and different frames per second (see Table 4) [2].

Name	Frames per second [Fps]	Frames [-]	Time [s]	SI [-]	TI [-]
Tree	50	500	10	36.0	11.3
Life	30	825	27.5	30.4	23.2

Table 4: Parameters of videos used in comparison

Figure 1: Used videos “Tree” and “Life”.

2.3. OBJECTIVE QUALITY METRICS

In our experiments, only full reference objective metrics were used to evaluate the video quality. All objective video quality metrics were calculated by VQM [4] and VQMT [5] programs. The used objective video metrics were Peak Signal-to-Noise Ratio (PSNR), Structural Similarity (SSIM) and Video Quality Metric (VQM) [6].

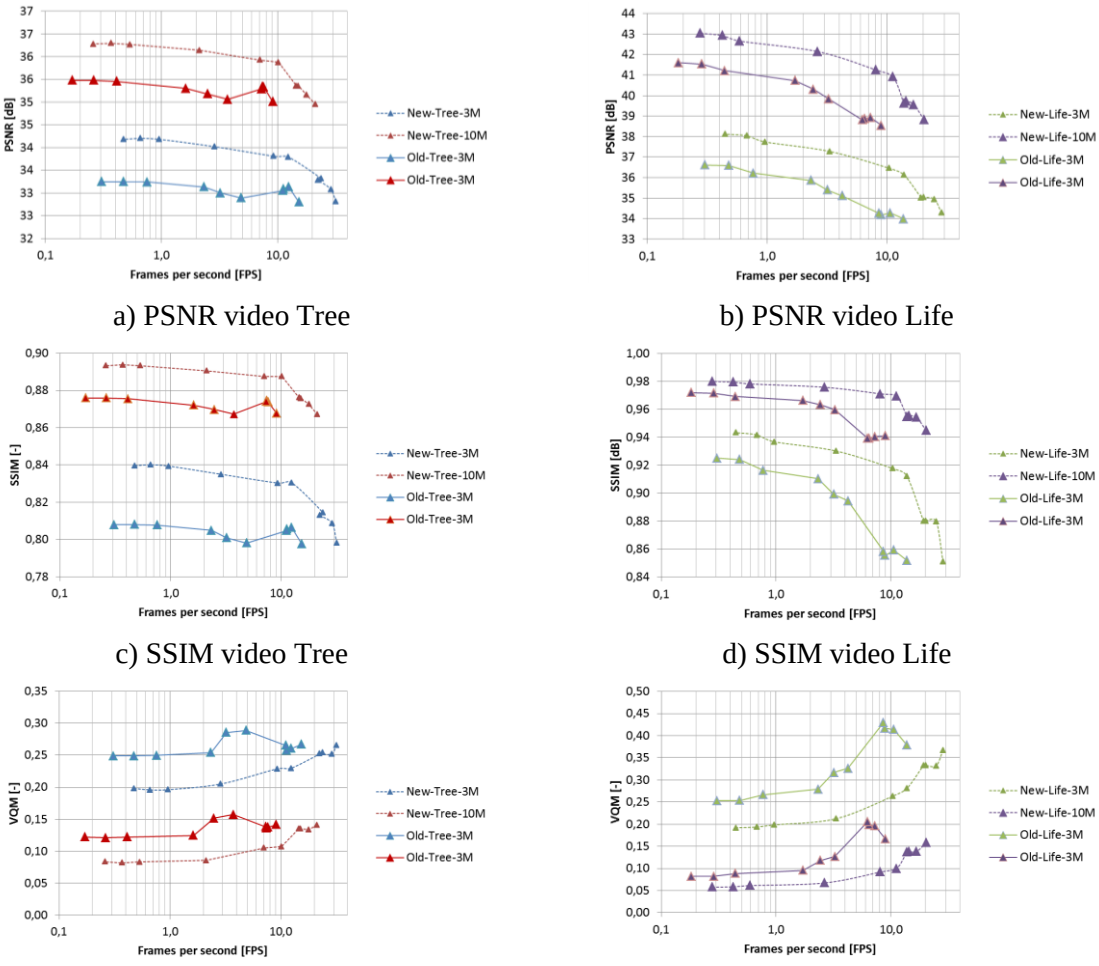
3. RESULTS AND EVALUATION

3.1. PREDEFINED QUALITY PROFILES

In this article, we also study the effect of predefined profiles on the video quality and on the sped of encoding. Similar analysis of this problem was described in [1] in detail. In our previous study, we explored that the higher quality profiles have not significant impact on the video quality, related to very slow encoding speed. When the speed of video encoding has the highest priority then it is recommended to set "Superfast" profile. The "Very Fast" and "Faster" profile provide very similar video quality like a "Superfast" but they are slower.

3.2. VERSIONS OF HEVC ENCODER

Two differently old versions of the same HEVC encoder implementation were chosen. The time difference between both versions is exactly one year (see in Table 1). Dependency of coding efficiency and the speed of encoding on the version of the encoder are shown in Figure 2.



a) PSNR video Tree

b) PSNR video Life

c) SSIM video Tree

d) SSIM video Life

e) VQM video Tree

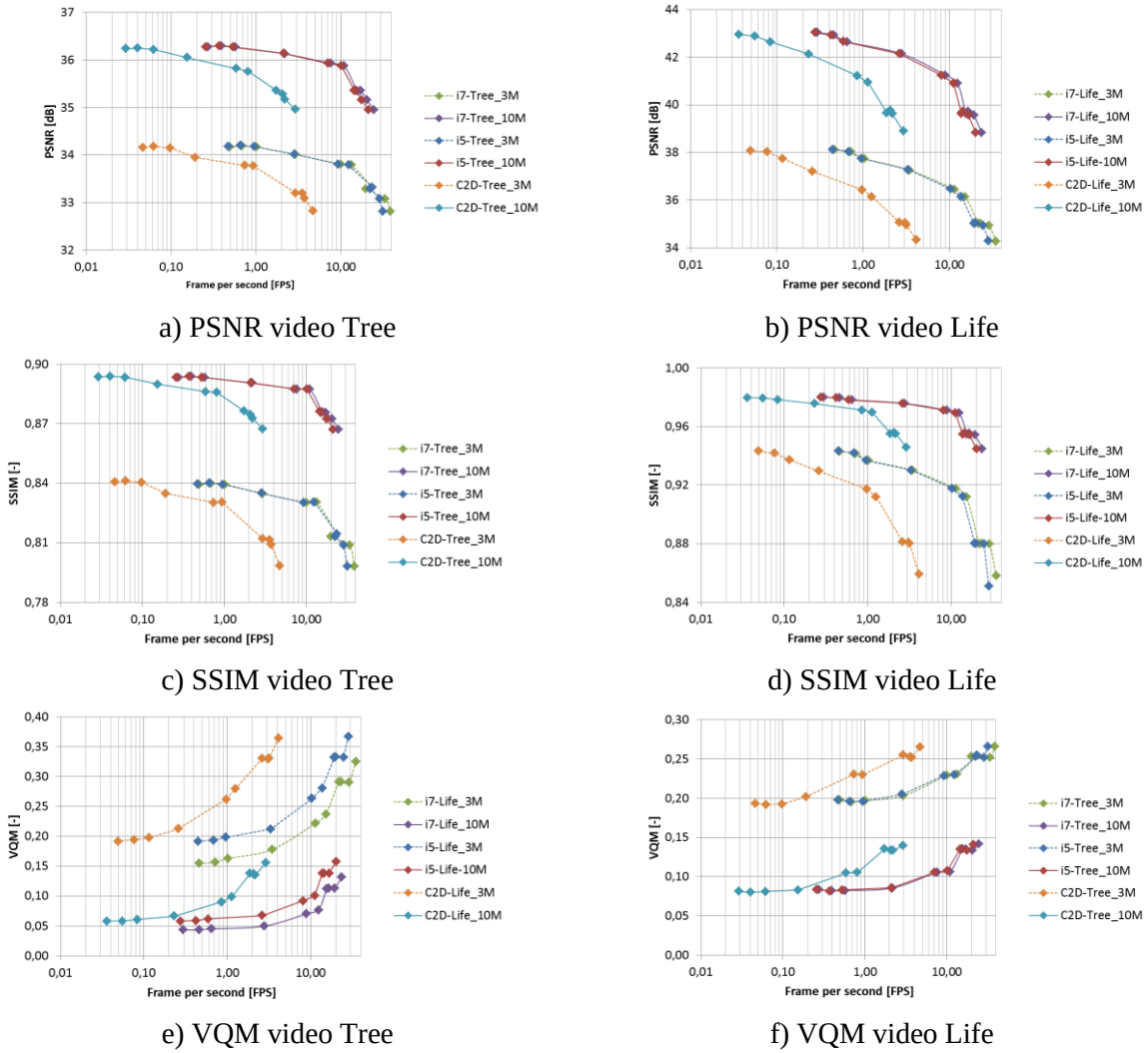
f) VQM video Life

Figure 2: Impact of the version of the encoder on the speed of encoding and video quality.

The best quality profiles (e.g. "Placebo") start on the left side of graphs and gradually, results for faster profiles (e.g. "Ultra Fast") are indicated on the right side. Name of dependencies (Legend) in figures is presented as follows: „version of the video codec_name of the video_bitrate". Results show that different versions of the same encoder have a different influence on the speed of encoding and on the final video quality. For example, the speed of the encoding at older encoder with profile "Medium" for video "Tree" at bitrate 10 Mbps was 2.5 fps whereas, with the new version of the encoder the speed of encoding was 7 fps (see Figure 2 a)). The PSNR is increased from 35.0 dB (old version of the encoder) to 35.8 dB (new version of the encoder). The performance of the old version of the encoder is not uniform. Especially, in the case of "Ultrafast" profile, the speed of encoding is increased from 9 fps to 22 fps for video "Tree" while the changes in video quality are negligible. This is very close to real-time encoding.

3.3. PROCESSOR ARCHITECTURE OF PC

In this subsection, we focus on the study of the influence of processor architecture from the point of encoding speed. Furthermore, we explore the impact of newer instruction set of the processor on the video quality. Advanced Vector Extensions (AVX) and Streaming SIMD Extensions 4 (SSE4) are new extensions of the instruction set which are supported only by the PC with processor i5 and i7. These extensions can be helpful from the point of video encoding speed. The speed of encoding as dependence of fps vs. objective metric on the processor architecture is shown in Figure 3. In this study, only the new version of HEVC encoder was used.



a) PSNR video Tree

b) PSNR video Life

c) SSIM video Tree

d) SSIM video Life

e) VQM video Tree

f) VQM video Life

Figure 3: Impact of the architecture of processor on the speed of encoding and video quality.

We know that, theoretically, the processor with C2D has approximately five times weaker performance than other two processors (see Table 3). But what effect will this have on the encoding performance? The impact of processor cores for some implementations is insignificant, for example for the default HM implementation. This implementation can handle only with one core.

Name of dependencies (Legend) in figures is presented as follows: "the name of the PC_name of the video_bitrate". For example, the speed of the encoding on C2D with quality profile "Medium" for video "Tree" at bitrate 10 Mbps was just 0.6 fps whereas, with the processor i5 and i7 it is 7 fps and 7.5 fps, respectively (see Figure 3 a)). When we compare the speed of encoding on C2D and on i5, where i5 has clock frequency higher about 24 %, the encoding speed of i5 is faster by 1200 %. It is an extreme speed up of the encoding. In the profile "Fast" the difference between i5 and i7 is only few percent. In faster profiles the difference between new processors is about 15 %. Processor i7 can fully take advantage of the Hyper-Threading. In these profiles C2D is eight times slower than i5 and i7 processors.

4. CONCLUSION

In this paper, the performance of the HEVC encoder and its predefined quality profiles on the video quality was analyzed. Our study was especially focused on the changes in coding efficiency due to the version of the encoder and on the influence of the architecture of the processor in PC. We have used three different computers. As it was mentioned, many papers deal only with different video codecs and their implementation, but study of predefined quality profiles of one implementation of the same codec is still missing. The main goal of this paper was to present a complete view about predefined quality profiles of x265 codec and explore the influence of its most probable settings on the video quality. Obtained results show that a new version of HEVC encoder has higher influence on the video quality and speed of the encoding is also higher. It was proved that PC with advanced architecture (but with the same clock frequency and with the same number of cores) could grow the speed of encoding by five times in comparison with old PC. Differences between the results obtained by various objective quality metrics are negligible (seen in Figure 2 and Figure 3).

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