Complexity Analysis of HM and JEM Encoder Software

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Abstract

During the 2nd JVET (Joint Group on Future Video Coding Technology Exploration) meeting, up to 22 coding tools focusing on Future Video Coding (FVC) were proposed. Despite that the application of proposed coding tools has a considerable performance enhancement, however, the encoding time of Joint Exploration Model (JEM) software is over 20 times for All Intra coding mode, 6 times for Random Access coding mode, of HEVC reference model (HM), and decoding time is 1.6 times for All Intra coding mode, 7.9 times for Random Access coding mode, of HM. This paper focuses on analyzing the complexity of the JEM software compared with HM.

Index terms : JEM software, Future Video Coding, HEVC, Complexity

1. Introduction

With the high-speed development of video coding, High Efficiency Video Coding (HEVC) standard [1], whose first draft was finished in 2013, has an over 50 percents performance enhancement compared to H.264/AVC which is the last video coding standard. Currently, ITU-T VCEG (Q6/16) and ISO/IEC are joined together to study the potential need for the standardization of future video coding technology with a compression capability that significantly exceeds that of the current HEVC [2]. The future video coding standard mainly considers higher resolutions, frame-rates, bit-depths, wide color gamut, high dynamic range, and 5G network services [3].

In the latest JEM software [4], compared with the HEVC, the whole coding structure is kept the same, totally 22 coding tools are added and some design elements are somewhat modified, the main modifications are listed below in the table 1 [5]

Table1. Coding Tools Added to JEM

Classification	Tools or Modification
Block Structure	Larger Coding Tree Unit (up to 256x256) and transforms (up to 64x64)
	Quadtree plus binary tree (QTBT) block structure
Intra Prediction Improvement	65 intra prediction directions
	4-tap interpolation filter for intra prediction
	Boundary filter applied to other directions in addition to horizontal and vertical ones
	Cross-component linear model (CCLM) prediction
	Position dependent intra prediction combination (PDPC)
	Adaptive reference sample smoothing
Inter Prediction Improvement	Sub-PU level motion vector prediction
	Locally adaptive motion vector resolution (AMVR)
	Overlapped block motion compensation (OBMC)
	Local illumination compensation (LIC)
	Affine motion prediction
	Pattern matched motion vector derivation
	Bi-directional optical flow (BIO)
Transform	Explicit multiple core transform
	Mode dependent non-separable secondary transforms
	Signal dependent transform (SDT)
In-loop Filter	Adaptive loop filter (ALF)
Entropy	Enhanced CABAC design

All the tools and designs are integrated or will be integrated into JEM main software except for the QTBT which is currently still under study.

2. Complexity Analysis of HM and JEM

In this section, the complexity of each module in the coding structure of HM and JEM are compared.

The comparison test was carried out mainly in four modules, intra prediction, inter prediction, transformation&quantization and entropy coding.

The test sequences are chosen from HEVC standard test sequences class B, including

- BQTerrace_1920x1080_60.yuv (denoted as S1)
- Cactus_1920x1080_50.yuv (denoted as S2)
- Kimono1_1920x1080_24.yuv (denoted as S3)
- ParkScene_1920x1080_24.yuv (denoted as S4)

The test figures of the JEM software are shown below. In the

table, LD represents Low Delay coding mode, RA represents Random Access coding mode.

Table 2. Encoding Time Percentage (JEM software)

JEM	LD_S1	LD_S2	RA_S3	RA_S4
Intra	10.8%	9.1%	8.1%	5.2%
Inter	44.7%	54.9%	67.1%	65.3%
Transform	37.5%	28.7%	22.2%	25.3%
Entropy	7.0%	7.2%	2.5%	4.3%

Table 3. Encoding Time Percentage (HM software)

HM	LD_S1	LD_S2	RA_S3	RA_S4
Intra	2.0%	1.1%	3.0%	1.9%
Inter	57.6%	66.8%	56.1%	61.4%
Transform	34.6%	27.33%	34.7%	31.9%
Entropy	5.8%	4.85%	6.3%	4.8%

And the four sequences encoding time comparison figures are shown in figure 1 to 4 respectively. From the experimental figures shown above, the influence that proposed JEM software tools (and some small change about structure design) made is that the percentage of intra prediction coding time and inter prediction coding time, since the large CTU up to 256x256 and up to 65 intra prediction modes are enabled in JEM software, the time for intra prediction is reasonably increased. Although the percentage of inter prediction encoding time is reduced, the real time that inter prediction used is highly increased, for the reason that many inter prediction tools are enabled such as Sub-PU level motion vector prediction, AMVR, OBMC LIC, affine motion prediction, pattern matched motion vector derivation and bi-directional optical flow etc.

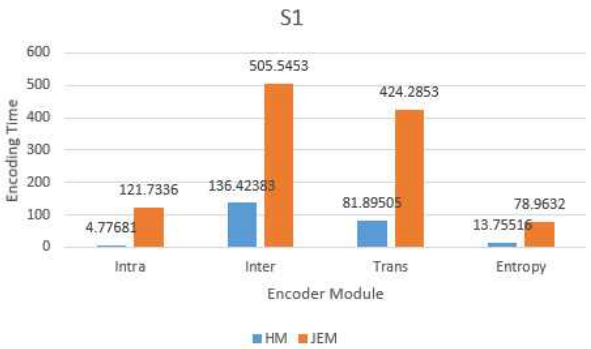

Figure 1: Sequence 1 Encoding Time Comparison

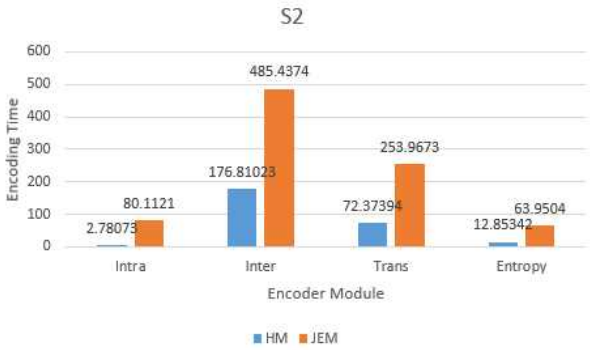

Figure 2: Sequence 2 Encoding Time Comparison

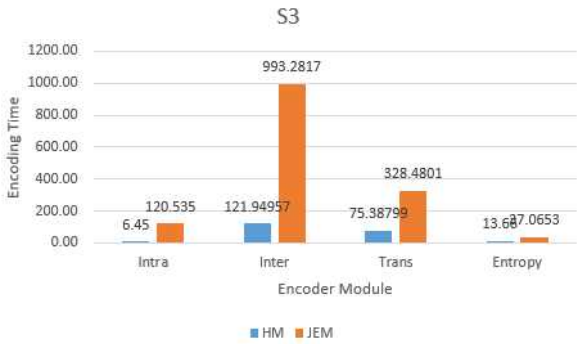

Figure 3: Sequence 3 Encoding Time Comparison

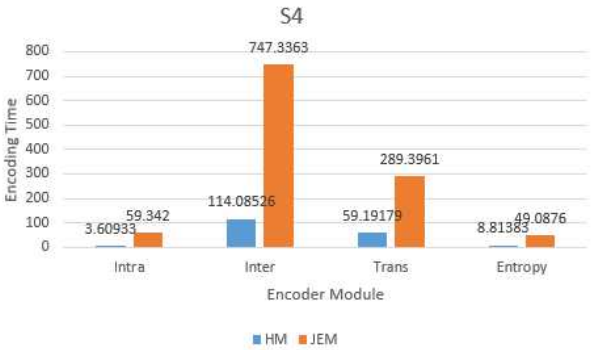

Figure 4: Sequence 4 Encoding Time Comparison

3. Conclusion

The analysis experiment of HEVC and JEM software was carried out according to the contributions proposed during the 2nd JVET meeting. From the experimental analysis data illustrated above, compared to the HM software, in JEM software, the intra prediction has a higher proportion than it in HM software. Owing to many proposed coding tools, the encoding time of each part is considerably increased.

The tool-on test and tool-off test will be carried out in the near future. in the tool-on test and tool-off test, each proposed tool will be analysed separately, and each tool's influence to the whole coding structure will also be estimated.

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