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| *Title:* | **Early SKIP Detection for HEVC** | | |
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| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | Jungyoup Yang Jaehwan Kim Kwanghyun Won Hoyoung Lee Byeungwoo Jeon  Sungkyunkwan University 300 Chunchun-dong, Jangan-gu, Suwon, Korea | Tel: Email: | +82-31-290-7186 [binbak1@ece.skku.ac.kr](mailto:binbak1@ece.skku.ac.kr) +82-31-290-7186 [kjh4759@skku.edu](mailto:kjh4759@skku.edu) +82-31-290-7186 [wkh12345@skku.edu](mailto:wkh12345@skku.edu) +82-31-290-7186 [hoiing@skku.edu](mailto:hoiing@skku.edu) +82-31-290-7144 [bjeon@skku.edu](mailto:bjeon@skku.edu) |
| *Source:* | Sungkyunkwan University | | |

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# Abstract

In this contribution, an early detection of SKIP mode is proposed to reduce an encoding complexity of HEVC. The proposed method is in the same spirit with the early skip detection scheme implemented in MPEG-4 Part 10 AVC/H.264 reference SW, but slightly modified to address the different encoding scheme of HEVC. It is reported that the proposed method reduces the encoding time by about 33% with BD-bitrate loss of 0.45% compared to HM4.0 encoder.

# Introduction

Reduction of encoding complexity of HEVC is very desired in many real applications. In that aspect, a fast mode decision method (JCTVC-F092 [1]) was adopted in the last Torino JCT-VC meeting. We note the effective early skip detection scheme in MPEG-4 Part 10 AVC/H.264 reference SW [2-4], and propose its modified early skip detection method tailored for HEVC.

# Proposed encoder description

To decide the best PU mode, the HM4.0 encoder [5] computes the RD costs of all the possible inter PU modes and intra PU modes as shown in Fig. 1. Since each of them entails high computational complexity, it is practically very desirable if the encoder can decide the best PU mode at the earliest possible stage without checking all possible modes exhaustively.

This contribution proposes an early detection of SKIP mode to reduce the encoding complexity of HEVC by simply checking the differential motion vector (DMV) and a coded block flag (CBF) after searching the best Inter 2Nx2N mode. The flowchart of the proposed method is depicted in Fig. 2. As shown in Fig.2, in the proposed method, the current CU searches Inter 2Nx2N modes (AMVP and Merge) before checking the SKIP mode. After selecting the best Inter 2Nx2N mode having the minimum RD cost, the proposed method checks its DMV and CBF. If DMV and CBF of the best Inter 2Nx2N mode are respectively equal to (0, 0) and zero (these two conditions are called as "early SKIP conditions"), the best mode of current CU is determined early as the SKIP mode. By doing this, in other words, the remaining PU modes are not investigated anymore. The proposed method can omit RD calculation for the other modes, thus reducing encoding complexity without sizable coding efficiency loss. To realize this idea, the proposed method only requires, with respect to the current HM4.0, one simple processing order change of PU mode search and checking the early SKIP conditions. Therefore it can be easily implemented into the current HM4.0 encoding structure. The concept of the proposed method is similar to the early SKIP detection method which is already adopted in JM software [2].

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| Fig. 1. Mode decision process of HM4.0 |

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| Fig. 2. Mode decision process of the proposed method |
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| Fig. 3. Mode decision process of the combined method |

In addition, the proposed method can be easily combined with the fast mode decision method which was adopted in the last Torino JCT-VC meeting [1]. The flowchart of the combined method is depicted in Fig. 3. As shown in Fig. 3, these fast mode decision methods are implemented independently.

# Experimental results

The proposed method is implemented on HM4.0 software. Table 1 shows the summarized encoding time reduction and coding performance of the proposed method compared to HM4.0 anchor. As shown in Table 2, the combined method (proposed method and JCTVC-F092) is summarized. The encoding environment is same as JCTVC-F900 [6]. Detailed results are included in JCTVC-G543.xls and JCTVC-G543\_F092.xls.

Table 1. Experimental results of the proposed method compared to the HM4.0 anchor

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Random Access HE | | | Random Access LC | | |
| Y | U | V | Y | U | V |
| Class A | 0.2% | -0.2% | -0.2% | 0.2% | -0.1% | -0.1% |
| Class B | 0.3% | -0.1% | -0.2% | 0.4% | -0.1% | -0.1% |
| Class C | 0.4% | -0.1% | 0.0% | 0.4% | -0.1% | 0.0% |
| Class D | 0.5% | -0.2% | -0.2% | 0.4% | -0.2% | -0.2% |
| Class E |  |  |  |  |  |  |
| Class F |  |  |  |  |  |  |
| **Overall** | 0.4% | -0.2% | -0.2% | 0.3% | -0.1% | -0.1% |
|  | 0.4% | -0.1% | -0.1% | 0.3% | -0.1% | -0.1% |
| Enc Time[%] | 69% | | | 66% | | |
| Dec Time[%] | 98% | | | 100% | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Low delay B HE | | | Low delay B LC | | |
| Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 0.4% | -0.1% | -0.1% | 0.4% | 0.0% | 0.1% |
| Class C | 0.4% | 0.0% | 0.0% | 0.3% | 0.2% | -0.1% |
| Class D | 0.6% | 0.5% | 0.2% | 0.4% | -0.2% | 0.0% |
| Class E | 0.6% | 0.2% | 1.0% | 0.7% | 0.6% | -0.1% |
| Class F |  |  |  |  |  |  |
| **Overall** | 0.5% | 0.1% | 0.2% | 0.4% | 0.1% | 0.0% |
|  | 0.5% | 0.1% | 0.2% | 0.4% | 0.1% | 0.0% |
| Enc Time[%] | 66% | | | 63% | | |
| Dec Time[%] | 99% | | | 97% | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Low delay P HE | | | Low delay P LC | | |
| Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 0.5% | -0.1% | 0.0% | 0.4% | -0.1% | -0.2% |
| Class C | 0.4% | 0.0% | -0.1% | 0.3% | -0.1% | 0.1% |
| Class D | 0.7% | -0.4% | -0.2% | 0.4% | -0.2% | -0.2% |
| Class E | 0.8% | 0.3% | -0.1% | 0.7% | 0.0% | -0.4% |
| Class F |  |  |  |  |  |  |
| **Overall** | 0.6% | -0.1% | -0.1% | 0.5% | -0.1% | -0.2% |
|  | 0.6% | -0.1% | -0.2% | 0.5% | -0.1% | -0.2% |
| Enc Time[%] | 72% | | | 68% | | |
| Dec Time[%] | 97% | | | 96% | | |

Table 2. Experimental results of the combined method compared to the HM4.0 anchor

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Random Access HE | | | Random Access LC | | |
| Y | U | V | Y | U | V |
| Class A | 1.5% | -1.0% | -1.2% | 1.7% | -0.8% | -0.7% |
| Class B | 2.1% | -0.9% | -0.9% | 2.3% | -0.9% | -0.8% |
| Class C | 2.0% | -0.3% | 0.1% | 2.2% | -0.3% | 0.1% |
| Class D | 2.2% | -0.7% | -0.4% | 2.4% | -1.0% | -0.6% |
| Class E |  |  |  |  |  |  |
| Class F |  |  |  |  |  |  |
| **Overall** | 1.9% | -0.7% | -0.6% | 2.2% | -0.7% | -0.5% |
|  | 1.9% | -0.7% | -0.6% | 2.2% | -0.7% | -0.5% |
| Enc Time[%] | 51% | | | 44% | | |
| Dec Time[%] | 96% | | | 98% | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Low delay B HE | | | Low delay B LC | | |
| Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 1.5% | -0.6% | -0.6% | 1.5% | -0.7% | -0.6% |
| Class C | 1.2% | 0.1% | 0.0% | 1.0% | 0.2% | 0.0% |
| Class D | 1.5% | -0.5% | -0.3% | 1.1% | -1.1% | -1.1% |
| Class E | 1.9% | -1.2% | -0.3% | 1.8% | -2.1% | -1.3% |
| Class F |  |  |  |  |  |  |
| **Overall** | 1.5% | -0.5% | -0.3% | 1.4% | -0.8% | -0.7% |
|  | 1.5% | -0.5% | -0.3% | 1.4% | -0.8% | -0.7% |
| Enc Time[%] | 48% | | | 45% | | |
| Dec Time[%] | 95% | | | 95% | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Low delay P HE | | | Low delay P LC | | |
| Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 1.8% | -1.0% | -1.0% | 1.7% | -1.0% | -1.1% |
| Class C | 1.3% | -0.3% | -0.4% | 1.1% | -0.5% | -0.5% |
| Class D | 1.7% | -1.8% | -1.3% | 1.4% | -1.6% | -1.6% |
| Class E | 1.6% | -2.3% | -1.5% | 1.4% | -2.5% | -2.4% |
| Class F |  |  |  |  |  |  |
| **Overall** | 1.6% | -1.3% | -1.0% | 1.4% | -1.3% | -1.3% |
|  | 1.6% | -1.3% | -1.1% | 1.4% | -1.3% | -1.3% |
| Enc Time[%] | 56% | | | 49% | | |
| Dec Time[%] | 94% | | | 93% | | |

# Conclusion

This contribution proposes an early detection of SKIP mode in the HM4.0. It is reported that the proposed method has a reduction of encoding time by about 33% on average with only a negligible loss of BD-bitrate 0.45% compared to HM 4.0. By detecting the SKIP mode at earliest possible stage, the proposed method reduced the encoding time with only a very negligible loss of coding performance. Furthermore, the proposed method can be applied easily in current HM4.0. The proposed method is also easy to be combined with other fast mode decision method which was adopted in HM4.0 anchor [1].

# References

[1] K. Choi, S.H. Park, and E.S. Jang, “Coding tree pruning based CU early termination,” JCTVC-F092, Torino, IT, July 2011.

[2] B. Jeon and J. Lee, “Fast mode decision for H.264,” JVT-J033, Hawaii, USA, December 2003.

[3] J. Lee and B. Jeon, “Fast mode decision for H.264,” IEEE International Conference Multimedia and Expo (ICME), June 2004.

[4] I. Choi, J. Lee, and B. Jeon, “Fast coding mode selection with rate-distortion optimization for MPEG-4 Part-10 AVC/H.264,” IEEE Trans. On Circuits and System for Video Technology, vol. 16, no. 12, pp. 1557-1561, Dec 2006.

[5] Thomas Wiegand, Woo-Jin Han, Benjamin Bross, Jens-Rainer Ohm, Gary J. Sullivan, “WD4: Working Draft 4 of High-Efficency Video Coding,” JCTVC-F803, Torino, IT, July 2011.

[6] F. Bossen, “Common test conditions and software reference configurations,” JCTVC-F900, Torino, IT, July 2011.

# Patent right declaration(s)

**Sungkyunkwan University may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**