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| *Title:* | **Suggestion on** **picture quality hierarchy for Low Delay configurations** | | | |
| *Status:* | Input Document to JCT-VC | | | |
| *Purpose:* | Proposal | | | |
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# Abstract

This contribution proposes a modification to the picture quality hierarchy for Low Delay settings in current HM. It is proposed to replace the current multi-level hierarchical picture quality structure by a two-level scheme. Average 0.2-0.3% BD-rate reduction is reported for Luma and average 1.8% BD-rate reduction is reported for Chroma. No impact on encoding or decoding time is observed.

1. Introduction

In HEVC HM3.0 the reference list for low delay B pictures uses the nearest reference pictures for both List0 and List1, as shown in Figure 1. An example is shown in Table 1.



Figure 1 – Reference pictures used in HM3.0 Low Delay default setting

Table 1 – Example for reference pictures used in HM3.0 Low Delay default setting

|  |  |  |
| --- | --- | --- |
| POC 0 | [L0 ] | [L1 ] |
| POC 1 | [L0 0 ] | [L1 0 ] |
| POC 2 | [L0 1 0] | [L1 1 0 ] |
| POC 3 | [L0 2 1 0] | [L1 2 1 0 ] |
| POC 4 | [L0 3 2 1 0 ] | [L1 3 2 1 0 ] |
| POC 5 | [L0 4 3 2 1 ] | [L1 4 3 2 1 ] |
| POC 6 | [L0 5 4 3 2 ] | [L1 5 4 3 2 ] |
| POC 7 | [L0 6 5 4 3 ] | [L1 6 5 4 3 ] |
| POC 8 | [L0 7 6 5 4 ] | [L1 7 6 5 4 ] |
| POC 9 | [L0 8 7 6 5 ] | [L1 8 7 6 5 ] |
| POC 10 | [L0 9 8 7 6 ] | [L1 9 8 7 6 ] |
| POC 11 | [L0 10 9 8 7 ] | [L1 10 9 8 7 ] |
| POC 12 | [L0 11 10 9 8 ] | [L1 11 10 9 8 ] |

In the 6th JCT-VC meeting, JCTVC-F433 was firstly adopted which, instead of using the four reference pictures nearest to the current picture, uses only the two nearest reference pictures and two of the high quality reference pictures. This is illustrated in Figure 2, with an example shown in Table 2.



Figure 2 – Reference pictures proposed in JCTVC-F433 for Low Delay default setting

Table 2 – Example for reference pictures proposed in JCTVC-F433 for Low Delay default setting

|  |  |  |
| --- | --- | --- |
| POC 0 | [L0 ] | [L1 ] |
| POC 1 | [L0 0 ] | [L1 0 ] |
| POC 2 | [L0 1 0] | [L1 1 0 ] |
| POC 3 | [L0 2 1 0] | [L1 2 1 0 ] |
| POC 4 | [L0 3 2 1 0 ] | [L1 3 2 1 0 ] |
| POC 5 | [L0 4 3 2 0 ] | [L1 4 3 2 0 ] |
| POC 6 | [L0 5 4 3 0 ] | [L1 5 4 3 0 ] |
| POC 7 | [L0 6 5 4 0 ] | [L1 6 5 4 0 ] |
| POC 8 | [L0 7 6 4 0 ] | [L1 7 6 4 0 ] |
| POC 9 | [L0 8 7 4 0 ] | [L1 8 7 4 0 ] |
| POC 10 | [L0 9 8 4 0 ] | [L1 9 8 4 0 ] |
| POC 11 | [L0 10 9 8 4 ] | [L1 10 9 8 4 ] |
| POC 12 | [L0 11 10 8 4 ] | [L1 11 10 8 4 ] |

Later in the meeting, JCTVC-F701 was adopted which obsoletes the JCTVC-F433 solution, such that in current HM4.0, the reference list for low delay B pictures uses only one nearest reference pictures for both List0 and List1, and three of the high quality reference pictures as shown in Figure 3. An example is shown in Table 3.

Figure 3 – Reference pictures used in HM4.0 (JCTVC-F701) Low Delay default setting

Table 3 – Example for reference pictures used in HM4.0 Low Delay default setting

|  |  |  |
| --- | --- | --- |
| POC 0 | [L0 ] | [L1 ] |
| POC 1 | [L0 0 ] | [L1 0 ] |
| POC 2 | [L0 1 0] | [L1 1 0 ] |
| POC 3 | [L0 2 1 0] | [L1 2 1 0 ] |
| POC 4 | [L0 3 2 1 0 ] | [L1 3 2 1 0 ] |
| POC 5 | [L0 4 3 2 0 ] | [L1 4 3 2 0 ] |
| POC 6 | [L0 5 4 3 0 ] | [L1 5 4 3 0 ] |
| POC 7 | [L0 6 5 4 0 ] | [L1 6 5 4 0 ] |
| POC 8 | [L0 7 6 4 0 ] | [L1 7 6 4 0 ] |
| POC 9 | [L0 8 7 4 0 ] | [L1 8 7 4 0 ] |
| POC 10 | [L0 9 8 4 0 ] | [L1 9 8 4 0 ] |
| POC 11 | [L0 10 8 4 0 ] | [L1 10 8 4 0 ] |
| POC 12 | [L0 11 8 4 0 ] | [L1 11 8 4 0 ] |

Note that in HM low delay settings, pictures are categorized into different quality layers. For example, if the first picture (which must be an I picture, and is the only I picture in the low delay sequence) has quantization parameter QP, then the every four B pictures (i.e. picture with POC 4, 8, 12, ..., i.e. pic(N), pic(N-4) and pic(N-8) in Figures 1-3) use QP+1. All these (QP+1) pictures, including the first I (QP) picture are referred as “high quality pictures” in this contribution. Then the B pictures in the middle of “high quality pictures” use QP+2, which are referred as “medium quality pictures” in this contribution. Finally the rest B pictures use QP+3, which are referred as “low quality pictures” in this contribution.

# Proposed Reference Picture Structure for Low Delay Settings

In this contribution, we propose a modified reference picture structure for Low Delay settings to HM. That is, the number of quality levels for B pictures in low delay settings is proposed to be two, i.e. “high quality” (QP+1) and “low quality” (QP+3), given the first I picture uses quantization parameter QP. The proposed reference list for low delay B pictures uses the nearest reference picture and three of the high quality reference pictures, as shown in Figure 4.

Figure 4 – Reference pictures used in the first proposed invention

By replacing the hierarchical picture quality structure with a two-level flat picture quality structure, the “RateGOP” size [1] may be easily set to any positive integer number (e.g. 3, 5, 7. etc.) rather than 2^N as typically defined when using the hierarchical scheme. More flexibility may be achieved for low delay applications. At the same time, coding gains are reported for both Luma and Chroma among various classes.

# Experimental Results

Simulations were conducted following common test conditions defined in JCTVC-F900 [1]. Anchor data was generated using HM4.0 software [2]. Results are shown in Table 4.

Table 4 Results using proposed reference picture structure for Low Delay settings.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Low delay B | | | Low delay B LoCo | | |
|  | Y BD-rate | U BD-rate | V BD-rate | Y BD-rate | U BD-rate | V BD-rate |
| Class A |  |  |  |  |  |  |
| Class B | 0.2 | -1.7 | -1.8 | 0.2 | -1.4 | -1.8 |
| Class C | -0.4 | -1.7 | -1.7 | -0.3 | -1.4 | -1.7 |
| Class D | -0.3 | -1.7 | -1.6 | -0.3 | -1.7 | -2.0 |
| Class E | -0.5 | -2.1 | -1.8 | -0.6 | -1.4 | -2.1 |
| All | -0.2 | -1.8 | -1.7 | -0.2 | -1.5 | -1.9 |
| Enc Time[%] | 99% | | | 99% | | |
| Dec Time[%] | 99% | | | 99% | | |
|  |  |  |  |  |  |  |
|  | Low delay P | | | Low delay P LoCo | | |
|  | Y BD-rate | U BD-rate | V BD-rate | Y BD-rate | U BD-rate | V BD-rate |
| Class A |  |  |  |  |  |  |
| Class B | 0.0 | -1.6 | -1.8 | 0.2 | -1.5 | -1.9 |
| Class C | -0.3 | -1.9 | -1.6 | -0.3 | -1.6 | -1.6 |
| Class D | -0.3 | -1.8 | -2.2 | -0.3 | -2.1 | -2.3 |
| Class E | -0.6 | -2.1 | -1.8 | -0.6 | -2.5 | -1.9 |
| All | -0.3 | -1.8 | -1.9 | -0.2 | -1.8 | -1.9 |
| Enc Time[%] | 99% | | | 99% | | |
| Dec Time[%] | 99% | | | 99% | | |

# Conclusions

This contribution suggests a modification to the picture quality hierarchy for Low Delay settings in current HM. That is, it is proposed to replace the current multi-level hierarchical picture quality structure by a simpler two-level scheme. Average 0.2-0.3% BD-rate reduction is reported for Luma and average 1.8% BD-rate reduction is reported for Chroma. It is recommended to include the proposed default setting in HM.

# Patent rights declaration(s)

**MediaTek Inc. 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).**

# References

1. Frank Bossen, “Common test conditions and software reference configurations”, JCTVC-F900, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T VCEG and ISO/IEC MPEG, Torino, Italy, July 2011.
2. HM 4.0 Software, <http://hevc.kw.bbc.co.uk/trac/browser/tags/HM-4.0>.