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| *Title:* | **Reference List Construction for Random Access Settings** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

In the 6th JCT-VC meeting, based on contribution JCTVC-F433 and JCTVC-F701, reference picture list construction by using 3 higher quality and 1 nearest reference pictures has been adopted for low delay setting. In the same spirit, this contribution proposes a similar scheme to construct reference picture list when random access setting is used. When constructing *RefPicListX*, the proposed scheme suggests sorting reference picture in Decoded Picture Buffer by POC first and then by QP relative to QP value of current picture, instead of only by POC as it is done currently. It is reported that the proposed scheme gives average coding gains of 0.4% Y, 0.4% U, and 0.4% V for RAHE and 0.5% Y, 0.8% U, and 0.7% V for RALC with not change to encoding and decoding running time.

# Introduction

Currently, reference picture construction process for *RefPicListX* as specified in WD 4 of HEVC [1] takes *n* nearest reference pictures after all available reference pictures in Decoded Picture Buffer (DPB) is sorted, where *n* denotes *NumOfReferenceB\_LX*. Temporal distance between current picture and reference picture is an important factor to select reference picture, however, in our opinion, since using reference pictures coded with better coding quality gives better inter prediction results, then coding quality of the reference pictures should also be taken into consideration. However, reference picture selection method that gives good trade-off between reference picture with relatively short temporal distance and relatively better / same coding quality is not available yet. In this contribution, we propose mechanism to select reference pictures that can give good temporal distance & coding quality trade-off when random access settings is used.

Figure 1 illustrates the result of current construction process for *RefPicList0* for picture 12 (picture with POC 12) and our suggestion for better choice. With current reference picture list construction, *RefPicList0* for picture 12 shall be {8,6}. Picture 8 is a good choice as reference because it is near and coded with smaller QP than that of picture 12, but picture 6 might not be a good choice because it is coded with higher QP. Instead of picture 6, we propose to use picture 4 as it is coded with same QP as that of picture 12 with trade off that it is relatively further distance from picture 12. Although picture 0 is coded with smaller QP, the temporal distance from picture 12 is relatively far so that it is not a good choice for reference picture.

Figure 1 – *RefPicList0* for Picture 12 when using current and the proposed schemes

# Proposed Reference Picture List Construction Process

Current scheme for reference picture list construction process sorts all reference pictures in DPB according to their POC. The proposed scheme for reference picture list construction process suggests further sorting the reference pictures in DPB by their QP relative to the QP of current picture. A reference picture in index *x* should be moved to *x*-1 in the sorted list if its QP is the same or smaller than that of current picture and the reference picture in the index *x*-1 has QP bigger than that of current picture.

The above suggestion can be described in steps as follows:

1. Sort reference pictures in DPB by their POC (in descending order for *RefPicList0* and in ascending order of *RefPicList1*)
2. The, sort reference pictures in DPB by applying the following pseudo-codes:

For (*ii* = 1 to the last index of entryShortTerm)

Set *jj* = *ii*;

While ((*jj* > 0) and

(POC(entryShortTerm [*jj*]) and POC(entryShortTerm [*jj -* 1]) are both lower or higher than POC(current picture))

(QP(entryShortTerm [*jj*]) <= QP(current picture)) and

(QP(entryShortTerm[*jj* – 1]) > QP(current picture)))

Swap entryShortTerm [*jj*] and entryShortTerm [*jj* – 1]

Set *jj* = *jj* – 1

By applying the above step 2, we are moving candidate reference pictures with same or better QP to smaller index to give it better chance to be selected in to *RefPicListX* instead of reference pictures with QP coarser than that of current picture. Figure 2 shows another example of the different of reference picture list constructed by using current scheme and the proposed scheme. *RefPicList0* for picture 16 when constructed by using current scheme shall contain {8, 6, 4, 0} while by using the proposed scheme it shall contain {8, 0, 6, 4}.

Figure 2 – *RefPicList0* for Picture 12 when using current and the proposed schemes

# Simulation Results

The proposed scheme has been implemented on top of HM-4.0 and the performance was measured under common test condition for RAHE and RALC configuration. The results are shown in Table 1.

Table 1 – Performance of the proposed scheme for RAHE & RALC with anchor HM-4.0

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access HE** | | | **Random Access LC** | | |
|  | Y | U | V | Y | U | V |
| Class A | -0.1% | -0.5% | -0.4% | -0.1% | -0.8% | -0.9% |
| Class B | -0.3% | -0.3% | -0.1% | -0.4% | -0.6% | -0.4% |
| Class C | -0.6% | -0.7% | -0.5% | -0.8% | -0.8% | -0.8% |
| Class D | -0.5% | -0.4% | -0.5% | -0.7% | -0.8% | -0.9% |
| Class E |  |  |  |  |  |  |
| **Overall** | -0.4% | -0.4% | -0.4% | -0.5% | -0.8% | -0.7% |
|  | -0.4% | -0.4% | -0.4% | -0.5% | -0.7% | -0.7% |
| Enc Time[%] | 100% | | | 100% | | |
| Dec Time[%] | 99% | | | 101% | | |

# Proposed Changes to WD Text

In order to accommodate the proposed scheme, we propose to change the WD text as follows (added text is highlighted with yellow color):

The reference picture list RefPicList0 is ordered such that short-term reference entries have lower indices than long-term reference entries. It is ordered as follows:

1. Let entryShortTerm be a variable ranging over all reference entries that are currently marked as "used for short‑term reference" and which have a value of temporal\_id equal to or lower than the temporal\_id of the current picture. When some values of entryShortTerm are present having PicOrderCnt( entryShortTerm ) less than PicOrderCnt( CurrPic ), these values of entryShortTerm are placed at the beginning of refPicList0 in descending order of PicOrderCnt( entryShortTerm ). All of the remaining values of entryShortTerm (when present) are then appended to refPicList0 in ascending order of PicOrderCnt( entryShortTerm ). Then, the entryShortTerm is further sorted as follow:

For (*ii* = 1 to the last index of entryShortTerm)

Set *jj* = *ii*;

While ((*jj* > 0) and

(PicOrderCnt(entryShortTerm [*jj*]) and PicOrderCnt(entryShortTerm [*jj-*1]) are both lower or higher than PicOrderCnt( CurrPic )) and

(QP(entryShortTerm [*jj*]) <= QP(current picture)) and

(QP(entryShortTerm [*jj* – 1]) > QP(current picture)))

Swap entryShortTerm [*jj*] and entryShortTerm [*jj* – 1]

Set *jj* = *jj* – 1

1. The long-term reference entries which have a value of temporal\_id equal to or lower than the temporal\_id of the current picture are ordered starting with the long-term reference entry that has the lowest LongTermPicNum value and proceeding through in ascending order to the long-term reference entry that has the highest LongTermPicNum value.

The reference picture list RefPicList1 is ordered so that short-term reference entries have lower indices than long-term reference entries. It is ordered as follows:

1. Let entryShortTerm be a variable ranging over all reference entries that are currently marked as "used for short‑term reference" and which have a value of temporal\_id equal to or lower than the temporal\_id of the current picture. When some values of entryShortTerm are present having PicOrderCnt( entryShortTerm ) greater than PicOrderCnt( CurrPic ), these values of entryShortTerm are placed at the beginning of refPicList1 in ascending order of PicOrderCnt( entryShortTerm ). All of the remaining values of entryShortTerm (when present) are then appended to refPicList1 in descending order of PicOrderCnt( entryShortTerm ). Then, the entryShortTerm is further sorted as follow:

For (*ii* = 1 to the last index of entryShortTerm )

Set *jj* = *ii*;

While ((*jj* > 0) and

(PicOrderCnt(entryShortTerm [*jj*]) and PicOrderCnt(entryShortTerm [*jj-*1]) are both lower or higher than PicOrderCnt( CurrPic )) and

(QP(entryShortTerm [*jj*]) <= QP(current picture)) and

(QP(entryShortTerm [*jj* – 1]) > QP(current picture)))

Swap entryShortTerm [*jj*] and entryShortTerm [*jj* – 1]

Set *jj* = *jj* – 1

1. Long-term reference entries which have a value of temporal\_id equal to or lower than the temporal\_id of the current picture are ordered starting with the long-term reference picture that has the lowest LongTermPicNum value and proceeding through in ascending order to the long‑term reference entry that has the highest LongTermPicNum value.
2. When the reference picture list RefPicList1 has more than one entry and RefPicList1 is identical to the reference picture list RefPicList0, the first two entries RefPicList1[ 0 ] and RefPicList1[ 1 ] are switched.

# Conclusion

This contribution proposes modification to current reference picture construction process for random access settings. The simulation results shows that the proposed scheme gives coding gains of 0.4% Y, 0.4% U, and 0.4% V for RAHE and 0.5% Y, 0.8% U, and 0.7% V for RALC.

We would like to recommend that the JCTVC considers adopting the proposed scheme when random access setting/configuration is used.

# Patent rights declaration(s)

**LG Electronics 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).**

# Reference

1. JCTVC-F803\_d5, “WD4: Working Draft 4 of High-Efficiency Video Coding,” 6th JCT-VC Meeting, 6th Meeting: Torino, IT, 14-22 July, 2011.