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| **INTERNATIONAL ORGANIZATION FOR STANDARDIZATION ORGANISATION INTERNATIONALE DE NORMALISATION ISO/IEC JTC 1/SC 29/WG 5 MPEG JOINT VIDEO CODING TEAM WITH ITU-T SG 16** |
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| **Mainz – 20–28 October 2022** |
| |  |  | | --- | --- | | **Title:** | **Exploration experiment on enhanced compression beyond VVC capability (EE2)** | | **Source:** | **Convenor (Jens-Rainer Ohm)** | | **Type:** | **General** | | **Subtype:** | **Other** | | **Status:** | **Approved** | | **Date:** | **2022-11-29** | | **Expected Action:** | **Info** | | **Action due date:** | **N/A** | | **No. of pages** | **20** (without this cover page) | | **Email of convenor:** | **ohm @ ient . rwth-aachen . de** | | **Committee URL:** | **https://sd.iso.org/documents/ui/#!/browse/iso/iso-iec-jtc-1/iso-iec-jtc-1-sc-29/iso-iec-jtc-1-sc-29-wg-5** | |

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| **Joint Video Experts Team (JVET)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29**  28th Meeting: Mainz, DE, 20–28 October 2022 | Document: JVET-AB2024-v3 |

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| --- | --- | --- | --- |
| *Title:* | **Exploration Experiment on Enhanced Compression beyond VVC capability (EE2)** | | |
| *Status:* | Output document to JVET | | |
| *Purpose:* | EE description | | |
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| *Source:* | EE coordinators | | |

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# Abstract

This document describes Exploration Experiments (EEs) planned to be performed between 28th and 29th JVET meetings to evaluate enhanced compression tools beyond VVC capability.

# Introduction

EE focus is to evaluate individual coding technologies and their combinations. Contributions improving compression efficiency further is highly encouraged.

EE related discussions shall happen on JVET reflector.

EE tests should be implemented on top the ECM software, ECM-7.0 is used as an anchor in the tests.

Tests shall be performed according to the CTC described in JVET-Y2017.

TGM class tests is required for SCC tests and is optional otherwise.

Palette mode shall be enabled for classes F and TGM in both ECM anchor and EE tests.

For RPR tests, in addition to ECM CTC the tests are performed following JVET-Q2015, where only LB configuration is mandatory.

AI and RA test configurations are required for intra tool testing, while RA and LB test configurations are required for inter tool testing. LP configuration is optional. In LB and LP configurations, the sequences length is reduced to 5 seconds for all classes.

If encoder modification is included in EE tests, such encoder optimization, if applicable, introduced to the anchor should be tested.

# Timeline

**T1** = 3 weeks (November 18, 2022) after JVET meeting: ECM is released

**T2** = T1 + 1 week (November 25, 2022): EE description is finalized

**T3** = T2 + 2 weeks (December 9, 2022): Initial software release for EE tests

**T4** = JVET meeting start – 3 weeks (December 21, 2022): Software in EE branches is frozen

# List of tests

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Intra prediction** | | | |
| 1.1 | Directional planar prediction | LGE  S. Yoo | InterDigital  K. Naser |
| 1.2 | Improvements on planar horizontal and planar vertical mode | WILUS  K. Kim | InterDigital  K. Naser |
| 1.3 | Horizontal and vertical planar modes | Alibaba  X. Li |  |
| 1.4 | Test 1.1 + Test 1.2 + Test 1.3 | LGE  S. Yoo  WILUS  K. Kim  Alibaba  X. Li |  |
| 1.6 | Chroma fusion | vivo  C. Zhou |  |
| 1.7 | Adaptive reference region DIMD | Sharp  Z. Fan | Xiaomi  P. Andrivon |
| 1.8 | Location-dependent DIMD | Nokia  S. Blasi | Xiaomi  P. Andrivon |
| 1.9 | TIMD with directional blending | Nokia  S. Blasi | Xiaomi  P. Andrivon |
| 1.10 | Optimizing the use of available decoded reference samples | InterDigital  T. Dumas |  |
| 1.11a | Test 1.8 + Test 1.9 | Nokia  S. Blasi | Xiaomi  P. Andrivon |
| 1.11b | Test 1.8 + Test 1.9 + Test 1.10 | Nokia  S. Blasi  InterDigital  T. Dumas | Xiaomi  P. Andrivon |
| 1.11c | Test 1.7 + Test 1.8 + Test 1.9 + Test 1.10 | Sharp  Z. Fan  Nokia  S. Blasi  InterDigital  T. Dumas | Xiaomi  P. Andrivon |
| 1.12a | Gradient and location based CCCM | Nokia  R. G. Youvalari |  |
| 1.12b | Gradient based CCCM | Nokia  R. G. Youvalari |  |
| 1.13 | CCCM using non-downsampled luma samples | Kwai  H.-J. Jhu |  |
| 1.14 | No luma subsampling for CCCM | Qualcomm  V. Seregin |  |
| 1.15 | Test 1.13 + Test 1.14 | Kwai  H.-J. Jhu  Qualcomm  V. Seregin |  |
| 2 Inter prediction | | | |
| 2.1 | Decoder-side affine model refinement | Alibaba  J. Chen |  |
| 2.2a | Sub-block processing for affine DMVR without subblock downsampling and without linear regression | Qualcomm  H. Huang  Alibaba  J. Chen |  |
| 2.2b | Sub-block processing for affine DMVR with subblock downsampling and without linear regression | Qualcomm  H. Huang  Alibaba  J. Chen |  |
| 2.2c | Sub-block processing for affine DMVR without subblock downsampling and with linear regression | Qualcomm  H. Huang  Alibaba  J. Chen |  |
| 2.2d | Sub-block processing for affine DMVR with subblock downsampling and with linear regression | Qualcomm  H. Huang  Alibaba  J. Chen |  |
| 2.3a | Control-point motion vector refinement for affine DMVR step 1 | Qualcomm  H. Huang |  |
| 2.3b | Control-point motion vector refinement for affine DMVR all steps | Qualcomm  H. Huang |  |
| 2.3c | Extension of affine DMVR to other modes | Qualcomm  H. Huang |  |
| 2.4a | Test 2.1 + Test 2. 3 | Qualcomm  H. Huang  Alibaba  J. Chen |  |
| 2.4b | Test 2.2 + Test 2. 3 | Qualcomm  H. Huang  Alibaba  J. Chen |  |
| 2.4c | Test 2.1 + Test 2.2 + Test 2.3 | Alibaba  J. Chen  Qualcomm  H. Huang |  |
| 2.5a | Pixel based affine motion compensation  (minimum subblock size is conditionally set to be 1×1 when OBMC flag is false, otherwise 4×4) | Qualcomm  Z. Zhang |  |
| 2.5b | Pixel based affine motion compensation  (minimum subblock size is alwsys set to be 1×1) | Qualcomm  Z. Zhang |  |
| 2.6a | ARMC merge candidate list reordering for AMVP-merge mode for low-delay pictures | Qualcomm  K. Cui  LGE  H. Jang |  |
| 2.6b | Adaptive merge candidate list reordering for AMVP-Merge mode at CU level | Qualcomm  K. Cui |  |
| 2.7a | Enhanced temporal motion information derivation | Bytedance  L. Zhao | Alibaba  J. Chen |
| 2.7b | Enhanced temporal motion information derivation with SbTMVP template matching using adjacent subblock MVs | Bytedance  L. Zhao  Tencent  L.-F. Chen | Kwai  X. Xiu |
| **3 Screen content coding** | | | |
| 3.1 | Direct block vector mode for chroma prediction (using CU level flag in MODE\_INTRA) | Xidian Univ.  J.-Y. Huo  X. Hao  OPPO  M. Li |  |
| 3.2 | Block vector difference sign prediction for IBC blocks | Xidian Univ.  J.-Y. Huo  X. Hao  OPPO  M. Li |  |
| 3.3a | Block Vector Difference Prediction for IBC blocks: 6 bins (2 sign bins and 4 suffix bins) | Ofinno  A. Filippov |  |
| 3.3b | Block Vector Difference Prediction for IBC blocks: 8 bins (2 sign bins and 6 suffix bins) | Ofinno  A. Filippov |  |
| 3.3c | Block Vector Difference Prediction for IBC blocks: 10 bins (2 sign bins and 8 suffix bins) | Ofinno  A. Filippov |  |
| 3.3d | Block Vector Difference Prediction for IBC blocks: 12 bins (2 sign bins and 10 suffix bins) | Ofinno  A. Filippov |  |
| 3.4 | BVP candidates clustering and BVD sign derivation for reconstruction-reordered IBC mode | Ofinno  D. Ruiz | Tencent  H. Zhang |
| 3.5 | Tests 3.1 + Test 3.2 + Test 3.3 + Test 3.4 | Xidian Univ.  J.-Y. Huo  X. Hao  OPPO  M. Li  Ofinno  A. Filippov  Ofinno  D. Ruiz |  |
| 3.6a | Combined IBC and intra prediction | Kwai  C. Ma  Bytedance  Y. Wang | OPPO  L. Zhang |
| 3.6b | Combined IBC and intra prediction (IBC-CIIP) | Bytedance  Y. Wang  Kwai  C. Ma | OPPO  L. Zhang |
| 3.6c | 3.6a + IBC with geometry partitioning (IBC-GPM) + IBC with local illumination compensation (IBC-LIC) | Kwai  C. Ma  Bytedance  Y. Wang | OPPO  L. Zhang |
| 3.6d | 3.6b + IBC with geometry partitioning (IBC-GPM) + IBC with local illumination compensation (IBC-LIC) | Bytedance  Y. Wang  Kwai  C. Ma | OPPO  L. Zhang |
| 3.7 | Chroma IBC method as in VTM-5.0 | Tencent  Y. Wang | Google  X. Li |
| 3.8 | Test 3.1 + Test 3.7 | Tencent  Y. Wang  Xidian Univ.  J.-Y. Huo  X. Hao  OPPO  M. Li |  |
| **4 Transform** | | | |
| 4.1a | Modifications of MTS and LFNST for IntraTMP coded block | WILUS  D. Kim |  |
| 4.1b | Generation of MPM list using the derived intra prediction mode | InterDigital  K. Naser |  |
| 4.1c | Test 4.1a + Test 4.1b | WILUS  D. Kim  InterDigital  K. Naser |  |
| 4.2a | Non-separable primary transform for intra coding | Qualcomm  P. Garus  LGE S. Kim | InterDigital K. Naser |
| 4.2b | Non-separable primary transform for intra coding with only *LFNST training set (to be clarified during the editing period)* used in training process for NSPT | Qualcomm  P. Garus  LGE S. Kim | InterDigital K. Naser |
| **5 In-loop filtering** | | | |
| 5.1a | Using prediction samples for adaptive loop filter | Kwai  C. Ma |  |
| 5.1b | Using residual samples for adaptive loop filter | Kwai  C. Ma |  |
| 5.2 | ALF with diversified extended taps | Bytedance  W. Yin |  |
| 5.3a | Test 5.1a + Test 5.2 | Kwai  C. Ma  Bytedance  W. Yin |  |
| 5.3b | Test 5.1b + Test 5.2 | Kwai  C. Ma  Bytedance  W. Yin |  |

# Tools description

## Intra prediction

### Test 1.1: Directional planar prediction (JVET-AB0104)

In this test, horizontal and vertical planar modes are investigated based on the DIMD mode information. The horizontal and vertical planar modes are considered as vertical and horizontal mode for transform selection, respectively.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.1 | Directional planar prediction | LGE  S. Yoo |

### Test 1.2: Improvements on planar horizontal and planar vertical mode (JVET-AB0110)

In this test, a derivation method of a transform kernel is applied for planar horizontal and planar vertical mode with the addtional restriction such as block sizes.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.2 | Improvements on planar horizontal and planar vertical mode | WILUS  K. Kim |

### Test 1.3: Horizontal and vertical planar modes (JVET-AB0162)

In this test, a decoder-side derivation method is proposed to decide which of the horizontal planar mode and the vertical planar mode is used. In additional, the propagated modes of the two new planar modes are modified when deriving transform kernel.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.3 | Horizontal and vertical planar modes | Alibaba  X. Li |

### Test 1.4: Improved directional planar prediction (JVET-AB0257)

Combinations of Test 1.1, Test 1.2 and Tests 1.3 are investigated

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.4 | Test 1.1 + Test 1.2 + Test 1.3 | LGE  S. Yoo  WILUS  K. Kim  Alibaba  X. Li |

### Test 1.6: Chroma fusion (JVET-AB0139)

In this test, a linear model-based chroma fusion method is proposed where the weights are derived by the adjacent template of both the reconstructed luma samples and the predicted chroma samples obtained by applying the non-LM mode.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.6 | Chroma fusion | vivo  C. Zhou |

### Test 1.7: Adaptive reference region DIMD (JVET-AB0065)

In this test, the adaptive reference region scheme is applied to DIMD mode to use DIMD\_TL(top, left, and top-left), DIMD\_T(top-left, top, and top-right), or DIMD\_L(top-left, left, and left-bottom) to derive DIMD model, and their combinations.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.7 | Adaptive reference region DIMD | Sharp  Z. Fan |

### Test 1.8: Location-dependent DIMD (JVET-AB0116)

In this test, sample-based blending of DIMD predictors is tested. Usage of sample-based blending is inferred during the DIMD mode derivation process, by analysing the histograms computed above and on the left of the current block. The weights used to blend the DIMD predictors are derived based on the histogram calculation process. In case sample-based blending is not used, conventional DIMD blending is used to blend the DIMD predictors.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.8 | Location-dependent decoder-side intra mode derivation | Nokia  S. Blasi |

### Test 1.9: TIMD with directional blending (JVET-AB0117)

In this test, directional blending is used to fuse predictors determined using TIMD. Separate TIMD modes are derived on the template above and the template on the left of the current block. The obtained predictors are blended using sample-based weights.

Diagram

Description automatically generated with medium confidence

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.9 | Template-based intra mode derivation with directional blending | Nokia  S. Blasi |

### Test 1.10: Optimizing the use of available decoded reference samples (JVET-AB0142)

For a given CB, the availabilities of the decoded reference samples in the above-right side and its bottom-left side are checked early during its encoding/decoding. Then, the CB coding is optimized depending on these availabilities. Precisely, the ordering of MPMs modes is modified according to the availablity. DIMD is modified to use these decoded reference samples if available. Finally, TIMD can use wide-angle modes that make intensive use of these decoded reference samples, if available.

In this test, the performance of the optimization of the use of available decoded reference samples will be investigated.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.10 | Optimizing the use of available decoded reference samples | InterDigitral  T. Dumas |

### Test 1.11: Combination tests

Combinations of Test 1.7, Test 1.8, Test 1.9 and Test 1.10 are investigated.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.11a | Test 1.8 + Test 1.9 | Nokia  S. Blasi |
| 1.11b | Test 1.8 + Test 1.9 + Test 1.10 | Nokia  S. Blasi  InterDigital  T. Dumas |
| 1.11c | Test 1.7 + Test 1.8 + Test 1.9 + Test 1.10 | Sharp  Z. Fan  Nokia  S. Blasi  InterDigital  T. Dumas |

### Test 1.12: Gradient and location based convolutional cross-component model for intra prediction (JVET-AB0119)

This contribution proposes a gradient and location based convolutional cross-component model (GL-CCCM) for chroma prediction to improve compression efficiency of ECM. The proposed 7-tap convolutional filter maps luma values into chroma values when a GL-CCCM prediction mode is activated by a PU level flag. The filter input consists of one spatial luma sample, two gradient values, two location information, a nonlinear term, and a bias term. Filter coefficients are derived for each chroma block separately using regression based MSE minimization (i.e., the same solver as CCCM) on reference samples in the PU’s neighborhood.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.12a | Gradient and location based CCCM | Nokia  R. G. Youvalari |
| 1.12b | Gradient based CCCM | Nokia  R. G. Youvalari |

### Test 1.13: CCCM using non-downsampled luma samples (JVET-AB0180)

In this test, the CCCM using non-downsampled luma samples is tested where the chroma samples are directly predicted from the original reconstructed luma samples, i.e., without downsampling. The proposed CCCM filter consists of 6-tap spatial terms, two nonlinear terms and a bias term. The 6-tap spatial terms correspond to 6 neighboring luma samples to the chroma sample to be predicted. For signaling, when the CCCM is selected, one single flag is signaled and used for both two chroma components to indicate whether the default CCCM model or the proposed CCCM model is applied. The performance impact of different filter shape and signaling levels will be investigated.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.13 | CCCM using non-downsampled luma samples | Kwai  H.-J. Jhu |

### Test 1.14: No luma subsampling for CCCM (JVET-AB0187)

In this test luma subsampling is disabled, derive and apply model on nonsubsampled luma samples directly. CCCM model shape is modofied, e.g. diamond 5x5 if subsampling is not applied. SPS flag is signalled to indicate whether luma subsampling is applied for CCCM. In the test, block-level decision vs. sequence-level decision, as well as performance impact from filter shapes will be studied.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.14 | No luma subsampling for CCCM | Qualcomm  V. Seregin |

### Test 1.15: Combintaion of CCCM without luma subsampling tests

Combinations of Test 1.13 and Test 1.14 are investigated.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.15 | Test 1.13 + Test 1.14 | Kwai  H.-J. Jhu  Qualcomm  V. Seregin |

## Inter prediction

### Test 2.1: Decoder-side affine model refinement (JVET-AB0145)

This contribution proposes to refine the affine model for affine coded blocks in decoder sider without additional signaling. In the proposed method, both the base MV and non-translation parameters of affine model are refined to improve the accuracy of the affine model inherited from the previously coded blocks.

In this test, one of the CPMVs is fixed as the base MV and the non-translation parameters are searched by minimizing the cost of bilateral matching. After the parameters refinment, the refined CPMV can be derived by the fixed baseMV and the refined parameters. And based on the refined CPMVs, the non-translation parameters can be further refined.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.1 | Decoder-side affine model refinement | Alibaba  J. Chen |

### Test 2.2: Sub-block processing for affine DMVR (JVET-AB0177)

The affine DMVR process is altered such that bilateral matching cost is calculated per sub-block. Then the subblock bilateral matching costs and refined subblock MVs are used to determine the overall best refined control-point motion vectors for the affine merge block.

Diagram

Description automatically generatedThe proposed method can be illustrated in the figure bellow, and summarized as the following:

1. Perform integer bilateral matching is for a subset of subblocks. Accumulate the subblock bilateral matching cost to determine the best integer MV offset.
2. Perform half-pel bilateral matching search using the best integer MV offset as initial offset and output a best MV offset that minimizes the bilateral matching cost for the same subset of subblocks in step 1.
3. Perform linear regression using the refined subblock MVs from step 1 as input and output a set of control-point motion vectors.
4. Compare the bilateral matching cost of the output of the steps 2 and 3 to select the one with the smallest cost.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.2a | Sub-block processing for affine DMVR without subblock downsampling and without linear regression | Qualcomm  H. Huang  Alibaba  J. Chen |
| 2.2b | Sub-block processing for affine DMVR with subblock downsampling and without linear regression | Qualcomm  H. Huang  Alibaba  J. Chen |
| 2.2c | Sub-block processing for affine DMVR without subblock downsampling and with linear regression | Qualcomm  H. Huang  Alibaba  J. Chen |
| 2.2d | Sub-block processing for affine DMVR with subblock downsampling and with linear regression | Qualcomm  H. Huang  Alibaba  J. Chen |

### Test 2.3: Control-point motion vector refinement for affine DMVR (JVET-AB0178)

CPMV refinement for affine DMVR is proposed, wherein a different MV offset may be applied to different control-point motion vectors. The method may be applied in merge candidate of affine merge mode and affine MMVD mode.

Given initial control-point motion vectors initCpMvLX[cpIdx] with cpIdx=0..numCpMv – 1, wherein the numCpMv is the number of CPMVs of the current affine coding block. The proposed method can be described in the following steps:

1. For each control-point, perform bilateral matching for a block that centered by the control-points to derive the refined CPMVs bmRefinedCpMvLx[cpIdx], as illustrated in Fig. 1. Loop over combinations of initCpMvLX[cpIdx] and bmRefinedCpMvLx[cpIdx], derive a best set of CPMVs that minimize the bilateral matching cost of the current block.
2. Iteratively further refine the CPMVs to minimize the bilateral matching cost of the current block. In each iteration, one CPMV is refined while the others are fixed.

The affine DMVR may be extended to be used in affine MMVD, adaptive BM, et al.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.3a | Control-point motion vector refinement for affine DMVR step 1 | Qualcomm  H. Huang |
| 2.3b | Control-point motion vector refinement for affine DMVR all steps | Qualcomm  H. Huang |
| 2.3c | Extension of affine DMVR to other modes | Qualcomm  H. Huang |

### Test 2.4: Combination of affine DMVR tests

Combinations of Test 2.1, Test 2.2 and Test 2.3.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.4a | Test 2.1 + Test 2.3 | Alibaba  J. Chen  Qualcomm  H. Huang |
| 2.4b | Test 2.2 + Test 2.3 | Alibaba  J. Chen  Qualcomm  H. Huang |
| 2.4c | Test 2.1 + Test 2.2 + Test 2.3 | Alibaba  J. Chen  Qualcomm  H. Huang |

### Test 2.5: Pixel based affine motion compensation (JVET-AB0168)

The proposed method set the minimum affine subblock size to be 1×1 for luma channel of an affined coded block. The pixel based affine MC or subblock based affine MC is adaptively applied depending on the determined subblock size. When adaptive affine subblock size is determined to have either width or height is smaller than 4, PROF is disabled.

In test a, the minimum affine subblock size is conditionally set to be 1×1 when OBMC flag is false, otherwise 4×4. In test b, the minimum affine subblock size is always set to be 1×1.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.5a | Pixel based affine motion compensation  (minimum subblock size is conditionally set to be 1×1 when OBMC flag is false, otherwise 4×4) | Qualcomm  Z. Zhang |
| 2.5b | Pixel based affine motion compensation  (minimum subblock size is alwsys set to be 1×1) | Qualcomm  Z. Zhang |

### Test 2.6: ARMC merge candidate list reordering for AMVP-merge mode for low-delay pictures (JVET-AB0151)

Template matching cost reordering method ARMC is used for merge candidate list reordering in AMVP-merge mode for low-delay pictures in the proposed method. In this mode, a merge candidate with the smallest cost after reordering is paired with the first AMVP candidate to derive the prediction.

In test a, the proposed method is studied and tested on the slice level. In test b, an adaptive selection of bilateral matching cost or template matching cost merge list reordering will be studied and tested on CU level.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.6a | ARMC merge candidate list reordering for AMVP-merge mode for low-delay pictures | Qualcomm  K. Cui  LGE  H. Jang |
| 2.6b | Adaptive merge candidate list reordering for AMVP-Merge mode at CU level | Qualcomm  K. Cui |

### Test 2.7: Enhanced temporal motion information derivation (JVET-AB0118, JVET-AB0150)

In this test, two aspects are proposed to further improve temporal motion information derivation, where two collocated frames are utilized and the motion shift to locate sbTMVP/TMVP is adaptively determined from multiple locations in an extended region. Besides, more sbTMVP candidates are introduced and ARMC for the sub-block-based merge candidate list is thereby modified.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.7a | Enhanced temporal motion information derivation | Bytedance  L. Zhao |
| 2.7b | Enhanced temporal motion information derivation with SbTMVP template matching using adjacent subblock MVs | Bytedance  L. Zhao  Tencent  L.-F. Chen |

## Screen content coding

### Test 3.1: Direct block vector mode for chroma prediction (JVET-AB0094)

In dual tree case, chroma block vector is employed to derive the prediction samples of chroma, where the chroma block vector is derived from luma block vectors by scaling.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.1 | Direct block vector mode for chroma prediction (using CU level flag in MODE\_INTRA) | Xidian Univ.  J.-Y. Huo  X. Hao  OPPO  M. Li |

### Test 3.2: Block vector difference sign prediction for IBC blocks (JVET-AB0095)

In the test, block vector difference sign prediction (BVDSP) is applied for IBC blocks when the block vector difference contains non-zero component. Possible BVD sign combinations are measured according to template cost, and index corresponding to the true BVD sign is derived and coded.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.2 | Block vector difference sign prediction or IBC blocks | Xidian Univ.  J.-Y. Huo  X. Hao  OPPO  M. Li |

### Test 3.3: Block Vector Difference Prediction for IBC blocks (JVET-AB0170)

Template matching operation is used to determine a BVD candidate with the best cost, and indicate in the bitstream whether the best candidate is predicted correctly or not. The bins of suffixes of BVD horizontal and vertical components are predicted, and the prediction match is context-coded in the bitstream. In the tests, different values of maximum number of sign and magnitude bins to be predicted for a PU are tested.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.3a | Block Vector Difference Prediction for IBC blocks: 6 bins (2 sign bins and 4 suffix bins) | Ofinno  A. Filippov |
| 3.3b | Block Vector Difference Prediction for IBC blocks: 8 bins (2 sign bins and 6 suffix bins) | Ofinno  A. Filippov |
| 3.3c | Block Vector Difference Prediction for IBC blocks: 10 bins (2 sign bins and 8 suffix bins) | Ofinno  A. Filippov |
| 3.3d | Block Vector Difference Prediction for IBC blocks: 12 bins (2 sign bins and 10 suffix bins) | Ofinno  A. Filippov |

### Test 3.4: BVP candidates clustering and BVD sign derivation for reconstruction-reordered IBC mode (JVET-AB0173)

In this test, a BVD inference method is proposed for the blocks encoded using the Reconstruction-Reordered IBC mode (RRIBC), and a candidate BVPs clustering method for the non-RRIBC encoded blocks.



Based on the BVP index, the BVD sign is inferred on the decoder side. The BVP clustering uses the L2 Euclidean distance between the candidate BVPs to group them, and the TM cost is computed for the candidates. The BVP with the lower cost is selected in each group as a regular BVP candidate in AMVP mode. Different clustering sizes and an extension of the BVD sign inferred method will be studied,

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.4 | BVP candidates clustering and BVD sign derivation for reconstruction-reordered IBC mode | Ofinno  D. Ruiz |

### Test 3.5: Combination of BVD tests

This test will provide the performance of the combinations of Test 3.1, Test 3.2, Test 3.3 and/or Test 3.4.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.5 | Tests 3.1 + Test 3.2 + Test 3.3 + Test 3.4 | Xidian Univ.  J.-Y. Huo  X. Hao  OPPO  M. Li  Ofinno  A. Filippov  Ofinno  D. Ruiz |

### Test 3.6: Extensions of intra block copy (JVET-AB0188, JVET-AB0191)

In JVET-AB0188, three aspects are proposed to extend the use of IBC:

**Aspect #1:** Combined IBC and intra prediction (IBC-CIIP)

When IBC-CIIP is applied to a CU, two prediction signals are obtained using IBC and intra prediction. The two prediction signals weighted summed to generate the final prediction. IBC-CIIP can be applied to IBC AMVP mode and IBC merge mode. A CU flag is signalled to indicate the use of IBC-CIIP.

**Aspect #2:** IBC with geometry partitioning (IBC-GPM)

When IBC-GPM is applied to a CU, the CU is divided into two sub-partitions geometrically. The prediction signals of the two sub-partitions are generated using IBC and intra prediction. IBC-GPM can be applied to IBC merge mode. A CU flag is signalled to indicate the use of IBC-GPM.

**Aspect #3:** IBC with local illumination compensation (IBC-LIC)

When IBC-LIC is applied to a CU, local illumination variation between the CU and its prediction block is modelled as a linear equation. The parameters of the linear equation are derived similar to LIC for inter prediction. IBC-LIC can be applied to IBC AMVP mode and IBC merge mode. For IBC AMVP mode, an IBC-LIC flag is signalled to indicate the use of IBC-LIC. For IBC merge mode, the IBC-LIC flag is inferred from the merge candidate.

In JVET-AB0191, It is proposed to combine the IBC with the intra prediction. The design of the combined IBC and intra prediction mode is similar to that of the existing CIIP, except that the inter part in CIIP is replaced with the IBC. Specifically, the IBC regular merge mode or IBC TM merge mode is combined with the PDPC mode or the TIMD mode.

For the syntax change, a flag is first signalled to indicate whether a prediction unit is coded with combined IBC and intra prediction mode. If this flag is true, another flag is signaled to indicate whether the intra part is generated based on the TIMD or the PDPC.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.6a | Combined IBC and intra prediction | Kwai  C. Ma  Bytedance  Y. Wang |
| 3.6b | Combined IBC and intra prediction (IBC-CIIP) | Bytedance  Y. Wang  Kwai  C. Ma |
| 3.6c | 3.6a + IBC with geometry partitioning (IBC-GPM) + IBC with local illumination compensation (IBC-LIC) | Kwai  C. Ma  Bytedance  Y. Wang |
| 3.6d | 3.6b + IBC with geometry partitioning (IBC-GPM) + IBC with local illumination compensation (IBC-LIC) | Bytedance  Y. Wang  Kwai  C. Ma |

### Test 3.7 Chroma IBC method as in VTM-5.0

Chroma IBC method same as in VTM-5.0, inherit Luma block vector(s) to corresponding chroma block/sub-blocks when available.

***List of tests to be performed***

|  |  |  |
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| # | Test | Tester |
| 3.7 | Chroma IBC method as in VTM-5.0 | Tencent  Y. Wang |

### Test 3.8 Combination of chroma IBC tests

Combinations of Test 3.1 and Test 3.7 are investigated.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.8 | Test 3.1 + Test 3.7 | Tencent  Y. Wang  Xidian Univ.  J.-Y. Huo  X. Hao  OPPO  M. Li |

## Transform

### Test 4.1: Modifications of MTS and LFNST for IntraTMP coded block (JVET-AB0115)

In this test, the derived intra prediction mode for Intra TMP coded blocks is used to determine the MTS set and the LFNST transform set, respectively. And then the derived intra prediction mode is used for generating the MPM list.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.1a | Modifications of MTS and LFNST for IntraTMP coded block | WILUS  D. Kim |
| 4.1b | Generation of MPM list using the derived intra prediction mode | InterDigital  K. Naser |
| 4.1c | Test 4.1a + Test 4.1b | WILUS  D. Kim  InterDigital  K. Naser |

### Test 4.2: Non-separable primary transform for intra coding (JVET-AB0175)

In this test Non-separable primary transforms (NSPTs) are used to replace DCT-II+LFNST for the block shapes 4x4, 4x8, 8x4, 8x8. In this test, a reduction of the number of NSPT kernels as well as NSPT-based solutions for larger block shapes will be studied.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.2a | Non-separable primary transform for intra coding | Qualcomm  P. Garus  LGE  S. Kim |
| 4.2b | Non-separable primary transform for intra coding with only *LFNST training set (to be clarified during the editing period what the LFNST training set is)* used in training process for NSPT | Qualcomm  P. Garus  LGE  S. Kim |

## In-loop filtering

### Test 5.1: Using prediction samples or residual samples for adaptive loop filter (JVET-AB0181)

In this test, using prediction samples or residual samples as additional inputs for ALF are tested. Two filter shapes, 1x1 and 3x3 diamond shapes, will be investigated to be applied on the additional ALF input.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.1a | Using prediction samples for adaptive loop filter | Kwai  C. Ma |
| 5.1b | Using residual samples for adaptive loop filter | Kwai  C. Ma |

### Test 5.2: ALF with diversified extended taps (JVET-AB0185)

In this test, several diversified extended taps are introduced into online-trained-filters of ALF. The diversified extended taps could take either the coded reference pictures or the intermediate filtering outputs generated by feeding reconstruction before DBF as input. The encoder could select the best input for these diversified extended taps. In each APS, one flag is signaled to indicate which input source is used.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.2 | ALF with diversified extended taps | Bytedance  W. Yin |

### Test 5.3: Combination of ALF tests

The combination of Test 5.1 and Test 5.2 is tested.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.3a | Test 5.1a + Test 5.2 | Kwai  C. Ma  Bytedance  W. Yin |
| 5.3b | Test 5.1b + Test 5.2 | Kwai  C. Ma  Bytedance  W. Yin |