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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** |
| **ISO/IEC JTC 1 / SC 29 / WG 5 N 209** |
| **Antalya, TR – 21–28 April 2023** |
| |  |  | | --- | --- | | **Title:** | **Exploration experiment on enhanced compression beyond VVC capability (EE2)** | | **Source:** | **Convenor (Jens-Rainer Ohm)** | | **Type:** | **General** | | **Subtype:** | **Other** | | **Status:** | **Approved** | | **Date:** | **2023-05-29** | | **Expected Action:** | **Info** | | **Action due date:** | **N/A** | | **No. of pages** | **14** (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**  30th Meeting, Antalya, TR, 21–28 April 2023 | Document: JVET-AD2024-v2 |

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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 30th and 31th 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-9.0 is used as an anchor in the tests.

Tests shall be performed according to the CTC described in JVET-AD2017.

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 (May 19, 2023) after JVET meeting: ECM is released

**T2** = T1 + 1 week (May 26, 2023): EE description is finalized

**T3** = T2 + 2 weeks (June 9, 2023): Initial software release for EE tests

**T4** = JVET meeting start – 3 weeks (June 20, 2023): Software in EE branches is frozen

# List of tests

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Partitioning** | | | |
| 1.1a | Partitioning prediction – run time level #1 | Canon  G. Laroche | InterDigital  S. Puri |
| 1.1b | Partitioning prediction – run time level #2 | Canon  G. Laroche | InterDigital  S. Puri |
| 1.1c | Encoder only partitioning prediction | Canon  G. Laroche | InterDigital  F. Le Léannec |
| **2 Intra prediction** | | | |
| 2.1a | Block vector guided CCCM with IBC BV | Nokia  R. Youvalari |  |
| 2.1b | Block vector guided CCCM with IBC and IntraTMP BV | Nokia  R. Youvalari |  |
| 2.2a | Extended IBC-GPM with two IBC predictions | Kwai C. Ma |  |
| 2.2b | Bi-predictive IBC-GPM | KDDI Y. Kidani |  |
| 2.2c | Test 2.2a + Test 2.2b | Kwai C. Ma  KDDI Y. Kidani |  |
| 2.3a | IBC BVP-merge | KDDI Y. Kidani |  |
| 2.3b | Test 2.3a + bi-predictive IBC merge without IBC-GPM | KDDI Y. Kidani |  |
| 2.3c | Test 2.3b + Test 2.2c (IBC-GPM) | KDDI Y. Kidani  Kwai C. Ma |  |
| 2.4a | IBC MBVD for camera captured content | Qualcomm  Z. Zhang | Ofinno  D. Ruiz Coll |
| 2.4b | Test 2.4a + Test 2.3a | Qualcomm  Z. Zhang  KDDI Y. Kidani | Ofinno  D. Ruiz Coll |
| 2.4c | Test 2.4a + Test 2.3c | Qualcomm  Z. Zhang  KDDI Y. Kidani  Kwai C. Ma |  |
| 2.5a | Filtered IBC | Kwai H.-J. Jhu |  |
| 2.5b | Filtering IBC predicted blocks | Qualcomm B. Ray |  |
| 2.5c | Test 2.5a + Test 2.5b | Kwai H.-J. Jhu  Qualcomm B. Ray | OPPO  Y. Yu  L. Zhang |
| 2.6a | IBC with non-adjacent spatial candidates | Kwai  C. Ma |  |
| 2.6b | Non-adjacent spatial candidates for IBC | Bytedance  Y. Wang |  |
| 2.6c | Test 2.6a + Test 2.6b | Kwai  C. Ma    Bytedance  Y. Wang |  |
| 2.7 | Cross-component merge mode with temporal candidates | MediaTek H.-Y. Tseng |  |
| 2.8 | An extrapolation filter-based intra prediction mode | OPPO  L. Xu |  |
| 2.9a | Extended Search areas for IntraTMP mode with scan order #1 | OPPO  Y. Yu  Xidian  Y. Ma,  H.Zhang  Kwai  X. Xiu | InterDigital  K. Naser |
| 2.9b | Extended Search areas for IntraTMP mode with scan order #2 | OPPO  Y. Yu  Xidian  Y. Ma,  H.Zhang  Kwai  X. Xiu | InterDigital  K. Naser |
| 2.9c | IntraTMP mode with partial extended search areas with scan order #1 | OPPO  Y. Yu  Xidian  Y. Ma  H. Zhang  Kwai  X. Xiu | InterDigital  K. Naser |
| 2.9d | IntraTMP mode with partial extended search areas with scan order #2 | OPPO  Y. Yu  Xidian  Y. Ma  H. Zhang  Kwai  X. Xiu | InterDigital  K. Naser |
| 2.10a | IBC-LIC without large block-size constraint | OPPO  Z. Xie |  |
| 2.10b | IBC-LIC extension | OPPO  Z. Xie |  |
| 2.10c | Test 2.10a + Test 2.10b | OPPO  Z. Xie |  |
| 2.11a | Harmonization between IBC HMVP and IBC-LIC | Bytedance  N. Zhang |  |
| 2.11b | Test 2.11a+Test 2.10 | Bytedance  N. Zhang  OPPO  Z. Xie |  |
| **3** **Inter prediction** | | | |
| 3.1a | Cross-component residual model | Nokia  P. Astola | InterDigital  F. Le Léannec |
| 3.1b | Cross-component residual model with complexity reductions | Nokia  P. Astola |  |
| 3.2 | Bi-predictive GPM | Ericsson  R. Yu |  |
| 3.3a | Additional TM refinement for bi-prediction | Bytedance  [Y. Wang](mailto:wangyang.cs@bytedance.com) |  |
| 3.3b | 16-point diamond search pattern for TM | Bytedance  [Y. Wang](mailto:wangyang.cs@bytedance.com) |  |
| 3.3c | Enabling TM for bi-prediction under DMVR condition | Bytedance  [Y. Wang](mailto:wangyang.cs@bytedance.com) |  |
| 3.3d | Test 3.3a + Test 3.3c | Bytedance  [Y. Wang](mailto:wangyang.cs@bytedance.com) |  |
| 3.3e | Test 3.3a + Test 3.3b + Test 3.3c | Bytedance  [Y. Wang](mailto:wangyang.cs@bytedance.com) |  |
| 3.4 | HPel flag and BCW weight usage in OBMC | InterDigital  [A. Robert](mailto:antoine.robert@interdigital.com) |  |
| 3.5 | Iterative BDOF pass in multi-pass DMVR | Bytedance  M. Salehifar  Alibaba  J. Chen |  |
| 3.6 | Affine AMVP mode with one MVD | Qualcomm H. Huang |  |
| 3.7a | RPR with new filters, scale factor 1.25x | Sharp [J. Samuelsson-Allendes](mailto:samuelssonj@sharplabs.com) |  |
| 3.7b | RPR with new filters, scale factor 1.33x | Sharp [J. Samuelsson-Allendes](mailto:samuelssonj@sharplabs.com) |  |
| **4 Transform and coefficient coding** | | | |
| 4.1 | Shifting quantizer center | InterDigital  M. Balcilar |  |
| 4.2 | Large NSPT | LGE  M. Koo |  |
| 4.3 | Context modelling for transform coefficients for LFNST/NSPT | Qualcomm  P. Nikitin |  |
| 4.4a | InterMTS is enabled for IBC-coded blocks in AMVP mode. | Qualcomm  P. Garus | InterDigital K. Naser |
| 4.4b | Test 4.4a + IntraTMP using interMTS instead of intraMTS kernels | Qualcomm  P. Garus |  |
| 4.4c | IntraMTS disabled for IntraTMP | Qualcomm  P. Garus |  |
| **5 In-loop filtering** | | | |
| 5.1a | CCSAO with temporal history offset | Kwai  C.-W. Kuo |  |
| 5.1b | Test 5.1a + extended edge classifier | Kwai  C.-W. Kuo |  |
| 5.2a | Applying fixed filters to samples before DBF | Qualcomm  N. Hu |  |
| 5.2b | Test 5.2a + extended classifiers for fixed filters | Qualcomm  N. Hu |  |
| 5.2c | Test 5.2b + applying the second fixed filter to outputs of the first fixed filter | Qualcomm  N. Hu |  |

# Tools description

## Partitioning

**Test 1.1: Temporal partitioning prediction (JVET-AD0130)**

In this test, the temporal prediction of the partitioning parameters is investigated. The allowances of splits as well as the partitioning depths are determined for each block according to the partitioning values obtained from a temporal area. The temporal partitioning values are the minimum or maximum or the average values of the QT Depth or MTT Depth. Two tests are proposed representing two different levels of encoding run time.

Encoder only partitioning prediction without signalling change, where the partitioning depth is guided by the partitioning from the previously coded picture, is tested. The partitioning prediction scheme should be close to the one used in the tests with the signalling change.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.1a | Partitioning prediction – run time level #1 | Canon  G. Laroche |
| 1.1b | Partitioning prediction – run time level #2 | Canon  G. Laroche |
| 1.1c | Encoder only partitioning prediction | Canon  G. Laroche |

## 2. Intra prediction

### Test 2.1: Block vector guided CCCM (JVET-AD0100)

In this test, block vector guided CCCM method is studied for improving the coding efficiency of ECM. The method uses block vector of the co-located luma block, coded in IBC or IntraTMP mode, to determine the reference area for calculating CCCM parameters. Then the reference area in luma and corresponding area in chroma channel is used to calculate CCCM parameters. The prediction uses the calculated model parameters and co-located luma samples to do the CCCM prediction. Two tests are studied:

Test 2.1a uses only IBC coded co-located luma block’s block vector for determining the CCCM reference area.

Test 2.1b uses IBC and IntraTMP coded co-located luma block’s block vector for determining the CCCM reference area.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.1a | Block vector guided CCCM with IBC BV | Nokia  R. Youvalari |
| 2.1b | Block vector guided CCCM with IBC and IntraTMP BV | Nokia  R. Youvalari |

### Test 2.2: Expended IBC-GPM (JVET-AD0215 and JVET-AD0134)

In the test, the existing IBC-GPM mode is further extended by allowing two GPM predictions generated with the IBC. There are two sub-tests:

In Test 2.2a, the two GPM predictions are derived based on the existing IBC merge candidate list with two separate indices signalled in bitstream.

In Test 2.2b, the bi-predictive IBC-GPM is applied to derive two BVs from existing IBC merge candidate lists, which are then applied to generate the two GPM predictions.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.2a | Extended IBC-GPM with two IBC predictions | Kwai C. Ma |
| 2.2b | Bi-predictive IBC-GPM | KDDI Y. Kidani |
| 2.2c | Test 2.2a + Test 2.2b | Kwai C. Ma  KDDI Y. Kidani |

### Test 2.3: Bi-predictive IBC (JVET-AD0134)

In this test, the performance of bi-predictive IBC for natural content and screen content is studied. The bi-predictive IBC consists of two types of methods. Method 1 is IBC BVP-merge mode, inspired by AMVP-merge mode, derives the two BVs from IBC BVP and IBC merge mode. Method 2 is bi-predictive IBC merge mode derives the two BVs from existing IBC merge candidate lists with two different indices. Method 2 targets not only regular IBC merge mode, but also IBC MBVD and IBC-GPM.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.3a | IBC BVP-merge | KDDI Y. Kidani |
| 2.3b | Test 2.2a + bi-predictive IBC merge without IBC-GPM | KDDI Y. Kidani |
| 2.3c | Test 2.2b + Test 2.2c (IBC-GPM) | KDDI Y. Kidani  Kwai C. Ma |

### Test 2.4: IBC MBVD (JVET-AD0396)

In this test, the performance of IBC MBVD for camera captured content is studied. In the test, it allows adaptive BVD offsets along MBVD directions. A combination test with Test 2.3 will study the performance of IBC merge for camera captured content.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.4a | IBC MBVD | Qualcomm  Z. Zhang |
| 2.4b | Test 2.4a + Test 2.3a | Qualcomm  Z. Zhang |
| 2.4c | Test 2.4a + Test 2.3c | Qualcomm  Z. Zhang |

### Test 2.5: Filtered IBC (JVET-AD0217, JVET-AD0223)

In this test, filtering is applied on top of IBC prediction as an additional mode. The 6-tap linear filter consists of 5 spatial luma samples in the reference block and a bias term. Filter coefficients are derived for each block using the regression based the minimized MSE on samples between the reference template and current template.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.5a | Filtered IBC | Kwai H.-J. Jhu |
| 2.5b | Filtering IBC predicted blocks | Qualcomm B. Ray |
| 2.5c | Test 2.5a + Test 2.5b | Kwai H.-J. Jhu  Qualcomm B. Ray |

### Test 2.6: IBC with non-adjacent spatial candidates (JVET-AD0216, JVET-AD0231)

In the test, non-adjacent spatial candidates are utilized for IBC candidate list construction. There are two sub-tests in the EE test.

In Test 2.6a, non-adjacent spatial candidates are added in-between the adjacent spatial candidates and the HBVP candidates of the candidate lists of both IBC merge and IBC AMVP.

In Test 2.6b, it is proposed to use non-adjacent spatial candidates for IBC merge candidates list construction. And the restriction that spatial candidates are not used to construct IBC merge candidate list for a 4x4 CU is removed.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.6a | IBC with spatial non-adjacent candidates | Kwai  C. Ma |
| 2.6b | Non-adjacent spatial candidates for IBC | Bytedance  Y. Wang |
| 2.6c | Test 2.6a + Test 2.6b | Kwai  C. Ma  Bytedance  Y. Wang |

### Test 2.7: Cross-component merge mode with temporal candidates (JVET-AD0048)

This test proposes to additionally include temporal candidates and shifted temporal candidates for chroma intra cross-component merge mode. The inclusion order of the temporal candidates and shifted temporal candidates will be further investigated.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.7 | Cross-component merge mode with temporal candidates | MediaTek  H.-Y. Tseng |

### Test 2.8: An extrapolation filter-based intra prediction mode (JVET-AD0081)

In this test, an extrapolation filter-based intra prediction mode is tested. Firstly, the mode coefficients are obtained from the neighboring reconstructed pixels of the current block with a pre-determined template. Secondly, the tested mode makes prediction signals for the current block from the top-left position to the bottom-right position in a parallel manner.

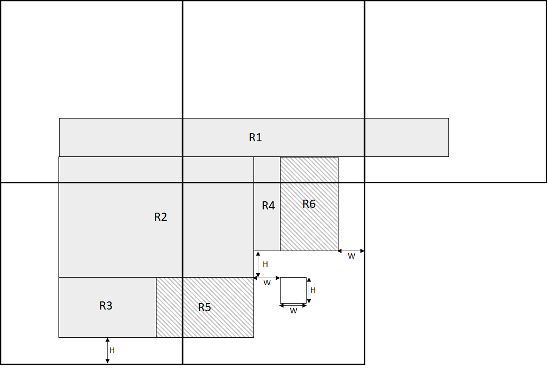
A size restriction is applied to the EIP mode.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.8 | An extrapolation filter-based intra prediction mode | OPPO  L. Xu |

**Test 2.9: Extended search areas for IntraTMP mode (JVET-AD0342)**

In this test, the bottom-left and top-right areas (i.e., R5 and R6) adjacent to the current block are added as additional search areas for intraTMP. In addition, all intraTMP search processes are conducted within a specified search range for all pre-determined search areas. Two area scan orders will be evaluated in the test. In order #1, the search areas are scanned in the order of R4, R5, R6, R1, R2 and R3. In order #2, the area scan order is R6, R4, R1, R2, R5 and R3. In addition, partial ranges of R5 and R6 are evaluated.



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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| Test 2.9a | Extended search areas for IntraTMP mode with scan order #1 | OPPO  Y. Yu  Xidian  Y. Ma, H.Zhang  Kwai  X. Xiu |
| Test 2.9b | Extended search areas for IntraTMP mode with scan order #2 | OPPO  Y. Yu  Xidian  Y. Ma，H. Zhang  Kwai  X. Xiu |
| Test 2.9c | IntraTMP mode with partial extended search areas with scan order #1 | OPPO  Y. Yu  Xidian  Y. Ma, H. Zhang  Kwai  X. Xiu |
| Test 2.9d | IntraTMP mode with partial extended search areas with scan order #2 | OPPO  Y. Yu  Xidian  Y. Ma，H. Zhang  Kwai  X. Xiu |

### Test 2.10: IBC-LIC extension (JVET-AD0083)

In the test, two new modes are proposed to allow only using the top or the left template, respectively. In addition, it is proposed to allow IBC-LIC to have multiple linear models in one CU, which is similar to MMLM.

IBC-LIC without large block constraint is also tested.

*L****ist of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.10a | IBC-LIC without large block-size constraint | OPPO  Z. Xie |
| 2.10b | IBC-LIC extension | OPPO  Z. Xie |
| 2.10c | Test 2.10a + Test 2.10b | OPPO  Z. Xie |

### Test 2.11: Harmonization between IBC HMVP and IBC-LIC (JVET-AD0127)

The IBC-LIC flag can be inherited from an IBC HMVP candidate to harmonize IBC HMVP and IBC-LIC similar to the inter LIC case.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.11a | Harmonization between IBC HMVP and IBC-LIC | Bytedance  N. Zhang |
| 2.11b | Test 2.11a+Test 2.10 | Bytedance  N. Zhang  OPPO  Z. Xie |

## 3. Inter prediction

### Test 3.1: Cross-component residual model (JVET-AD0108)

In this test the cross-component residual model is tested for improving the inter prediction of ECM. The mode uses convolutional cross-component prediction for inter blocks. The cross-component models are derived using the prediction signals and applied using the reconstructed luma signal. A second test is performed to reduce runtimes both at encoder and decoder by disabling certain features of the proposed tool.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.1a | Cross-component residual model | Nokia  P. Astola |
| 3.1b | Cross-component residual model with complexity reductions | Nokia  P. Astola |

### Test 3.2: Enhanced GPM (JVET-AD0064)

In this test, it is proposed to extend the existing uni-predictive GPM design to allow usage of bi-predictive motion vectors for generating motion compensated prediction samples for inter partitions. The GPM-related tools such as GPM-MMVD and GPM-TM are also modified to support such an extension.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.2 | Bi-predictive GPM | Ericsson  R. Yu |

### Test 3.3: High-Accuracy template matching (JVET-AD0155)

A method of high-accuracy template matching with three aspects is proposed to improve template matching. In aspect #1, an additional refinement is applied to TM for bi-prediction. In aspect #2, the diamond search pattern used in TM is modified from 8-point to 16-point. In aspect #3, TM for bi-prediction is also enabled when DMVR condition is satisfied.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.3a | Additional TM refinement for bi-prediction | Bytedance  [Y. Wang](mailto:wangyang.cs@bytedance.com) |
| 3.3b | 16-point diamond search pattern for TM | Bytedance  [Y. Wang](mailto:wangyang.cs@bytedance.com) |
| 3.3c | Enabling TM for bi-prediction under DMVR condition | Bytedance  [Y. Wang](mailto:wangyang.cs@bytedance.com) |
| 3.3d | Test 3.3a + Test 3.3c | Bytedance  [Y. Wang](mailto:wangyang.cs@bytedance.com) |
| 3.3e | Test 3.3a + Test 3.3b + Test 3.3c | Bytedance  [Y. Wang](mailto:wangyang.cs@bytedance.com) |

**Test 3.4: HPel flag and BCW weight usage in OBMC (JVET-AD0183)**

In this test, the HPel flags and the BCW weights of the neighbouring blocks and sub-blocks are considered into the OBMC process as both BCW and AMVR indexes can modify the predicted samples in the OBMC motion compensation. It is then proposed to incorporate them into the OBMC process to better fit the real predicted signal. When processing the top and left borders, the neighbouring BCW weights and HPel flags are used, and for the internal sub-block boundaries, these are the BCW and AMVR indexes of the current CU that are used.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.4 | Hpel flag and BCW weight usage in OBMC | InterDigital  [A. Robert](mailto:antoine.robert@interdigital.com) |

**Test 3.5: Iterative BDOF pass in multi-pass DMVR (JVET-AD0176 and JVET-AD0196)**

In ECM, multi-pass DMVR includes three passes, of which the first two passes are based on bilateral matching and the third pass is based on BODF. In this test, multi-pass DMVR is extended by introducing additional BDOF iteration, with possible subblock size adaptation.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.5 | Iterative BDOF pass in multi-pass DMVR | Bytedance  M. Salehifar  Alibaba  J. Chen |

**Test 3.6: Affine AMVP mode with one MVD (JVET-AD0180)**

In this test, a flag (named as affine1MvdFlag) is signalled for 6-parameter affine AMVP mode to indicate whether the 2nd and 3rd MVDs are all equal to the 1st MVD. Therefore, it is not needed to signal any bits for the 2nd and 3rdMVDs. In case of bi-prediction, all the MVDs in the list 1 are not signalled and inferred to be zeros. In addition, when deriving the affine constructed candidate, those neighbouring blocks that are coded with affine mode are first checked, then the regular inter coded block are checked.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.6 | Affine AMVP mode with one MVD | Qualcomm H. Huang |

**Test 3.7: RPR with new filters, scale factor 1.25x (JVET-AD0169)**

The RPR filters proposed in JVET-AD0169 to be used for scale factors:

* 1.1x to 1.35x are tested with scale factor 1.25x,
* 1.1x to 1.35x are tested with scale factor 1.33x.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.7a | RPR with new filters, scale factor 1.25x | Sharp [J. Samuelsson-Allendes](mailto:samuelssonj@sharplabs.com) |
| 3.7b | RPR with new filters, scale factor 1.33x | Sharp [J. Samuelsson-Allendes](mailto:samuelssonj@sharplabs.com) |

## 4. Transform and coefficient coding

### Test 4.1: Shifting quantization center (JVET-AD0251)

In this test, a shifting of de-quantized transform coefficients is applied. Specifically, some dequantized coefficients are shifted by a gradient proxy to compensate quantizer/entropy coding impact on coefficients.

The shifting of de-quantized transform coefficients is applied as follows. Assume denotes the quantization index of a transform coefficient.

where represents a de-quantized transform coefficient at position .

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.1 | Shifting quantization center | InterDigital  M. Balcilar |

### Test 4.2: Large NSPT (JVET-AD0187)

In this test, Non-Separable Primary Transform (NSPT) for large blocks such as Nx32/32xN (N = 4 or 8) is applied on top of the existing NSPT structure. Furthermore, more optimized architecture for improved coding performance and encoder speed-up will be investigated.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.2 | Large NSPT | LGE  M. Koo |

### Test 4.3: Context modelling for transform coefficients for LFNST/NSPT (JVET-AD0204)

In this test, an alternative context modelling for LFNST/NSPT is applied. The proposed method uses the previous 5 coefficients in the coding order to model the contexts of sig\_coeff\_flag, coeff\_abs\_level\_greaterX\_flag, and for the derivation of Rice parameter for parsing the remainder of the coefficient, rather than using the causal 2D neighbourhood for the context derivation.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.3 | Context modelling for transform coefficients for LFNST/NSPT | Qualcomm  P. Nikitin |

### Test 4.4: InterMTS for IBC and transform alignment with IntraTMP (JVET-AD0200)

In this test, interMTS is enabled for IBC-coded blocks. Furthermore, an alignment of transforms for intraTMP and IBC is studied.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.4a | InterMTS is enabled for IBC-coded blocks in AMVP mode. | Qualcomm  P. Garus |
| 4.4b | Test 4.4a + IntraTMP using interMTS instead of intraMTS kernels | Qualcomm  P. Garus |
| 4.4c | IntraMTS disabled for IntraTMP | Qualcomm  P. Garus |

## 5. In-loop filtering

**Test 5.1: CCSAO with extended edge classifiers and history offsets (JVET-AD0218)**

In this test, two modifications are investigated to improve the coding efficiency of CCSAO. Firstly, similar to the APS design in VVC, temporal historical CCSAO offsets are stored for the usage of future frames. Secondly, the edge classifier is extended with multiple edge/band combinations and the component used for edge classification can be selected from one of all three components.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.1a | CCSAO with temporal history offset | Kwai  C.-W. Kuo |
| 5.1b | Test 5.1a + extended edge classifier | Kwai  C.-W. Kuo |

**Test 5.2: Improved fixed filters for ALF (JVET-AD0220)**

In this test, firstly, a fixed filter is also applied to samples before DBF. Secondly, the classifiers of the fixed filters are extended. For each 2x2 block, the variance of a surrounding window is calculated. The variance is then quantized by a scaling factor which is determined based on the activity value derived from a Laplacian classifier. With *i*=0, 1, let *Ci* denote the classifier from the classifier of i-th fixed filter in ECM. The new class index is a combination of *Ci* and the quantized variance. Thirdly, the second fixed filter is applied to outputs of the fixed filter and samples before DBF.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.2a | Applying fixed filters to samples before DBF | Qualcomm  N. Hu |
| 5.2b | Test 5.2a + extended classifiers for fixed filters | Qualcomm  N. Hu |
| 5.2c | Test 5.2b + applying the second fixed filter to outputs of the first fixed filter | Qualcomm  N. Hu |