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| *Title:* | **CE2: Test3 – IBC with block vector derivation** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This proposal reports the simulation results with block vector derivation method (CE2 Test3) for improved intra block copy coding. The derived block vectors are used in intra block copy merge mode. Compared to CE2 anchors, the lossy coding of the proposed scheme reportedly achieves average {Y, U, V} BD rate gain of {-3.1%, -4.2%, -4.2%}, {-2.9%, -4.4%, -4.3%} and {-2.5%, -3.8%, -3.8%} for the category (RGB/YUV, text & graphics with motion, 1080p and 720p) for AI, RA and LDB, respectively. And the lossless coding reportedly achieves total bit-rate saving of 1.4%, 1.3% and 1.3% for the category (RGB/YUV, text & graphics with motion, 1080p and text & graphics with motion, 720p) for AI, RA and LDB, respectively.

# Introduction

Block vector (BV) derivation method was proposed in JCTVC-R0165 [2] to improve IntraBC coding. The derived BVs are used in IntraBC merge mode as additional merge candidates to improve the merge mode performance. For a coding unit coded with IntraBC, a normal BV, referred to as BV0, is signaled. Denote the reference block pointed to by BV0 as block B1 (as shown in Figure 1). If the top-left sub-block of block B1 is also coded using IntraBC, then block B1 also has a BV of its own, which is referred to as BV1. In this case, the derived BV, referred to BVd, is calculated as follows:

BVd = BV0 + BV1 (1)



Figure . BV derivation if the reference block is IntraBC coded block

## IntraBC merge mode using derived BV

BV derivation is used to derive IntraBC merge candidates for IntraBC merge mode. The maximum number of merge candidates for the proposed IntraBC merge mode is five. The merge candidate list is constructed with valid and unique BVs from the following possible candidates in order.

1. Five spatial BVs from neighboring blocks (C0 to C4) shown in Figure 2;
2. For each BV in the list obtained from (1) and (2), if the corresponding reference block is IntraBC mode and the corresponding derived BV is unique and valid for the current PU, then add the derived BV to the merge candidate list.



Figure . Spatial neighboring blocks for IntraBC merge candidate list construction

In the test, there are two constraints for BV derivation: (1) using local window within one CTU row above and current CTU row; (2) using compressed BV field. For the first constraint, if the block pointed by BV0 shown in Figure 1 is outside the local window, then it will be treated as invalid case and no BV derivation is applied.

# Simulation results

The compression performance of the proposed method is compared with CE2 anchors, using the CE2 test conditions [1]. We did two tests as listed in Table 1. Table 2 and Table 3 give the average BD rate reduction for test A for lossy and lossless coding, respectively. Test A and B results are provided in the accompanying spreadsheets for further details.

Table . The settings of tests

|  |  |  |
| --- | --- | --- |
| **Test** | **IntraBC merge with BV derivation** | **Normal IntraBC with BV/MV derivation** |
| A | Enabled | Disabled |
| B | Enabled | Enabled |

As shown in Table 2, for lossy coding, test A achieves average {Y, U, V} BD rate gain of {-5.0%, -6.4%, -6.2%}, {-4.2%, -6.1%, -5.8%} and {-4.0%, -5.4%, -5.2%} for the category (RGB, text & graphics with motion, 1080p) for AI, RA and LDB, respectively. As shown in Table 3, compared with CE2 anchors, for lossless coding, test A achieves total bit-rate saving of 2.8%, 2.6% and 2.7% for the category (RGB, text & graphics with motion, 1080p) for AI, RA and LDB, respectively.

Table 2. Average BD rate reduction for test A lossy coding compared with CE2 anchors

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All Intra** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p | -5.0% | -6.4% | -6.2% |
| RGB, text & graphics with motion,720p | -2.6% | -3.3% | -3.2% |
| RGB, mixed content, 1440p | -2.4% | -2.7% | -2.9% |
| RGB, mixed content, 1080p | -2.2% | -2.7% | -2.7% |
| RGB, Animation, 720p | -0.1% | -0.1% | -0.1% |
| RGB, camera captured, 1080p | 0.0% | 0.0% | 0.0% |
| YUV, text & graphics with motion, 1080p | -2.9% | -4.4% | -4.3% |
| YUV, text & graphics with motion,720p | -2.1% | -2.9% | -3.1% |
| YUV, mixed content, 1440p | -1.6% | -2.1% | -2.3% |
| YUV, mixed content, 1080p | -1.7% | -3.0% | -3.0% |
| YUV, Animation, 720p | -0.2% | -0.2% | -0.3% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 114% | | |
| Dec Time[%] | 96% | | |
|  |  |  |  |
|  | **Random Access** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p | -4.2% | -6.1% | -5.8% |
| RGB, text & graphics with motion,720p | -2.0% | -3.1% | -3.0% |
| RGB, mixed content, 1440p | -1.7% | -2.6% | -2.7% |
| RGB, mixed content, 1080p | -2.0% | -2.9% | -3.0% |
| RGB, Animation, 720p | -0.1% | -0.2% | -0.2% |
| RGB, camera captured, 1080p | 0.0% | 0.0% | 0.0% |
| YUV, text & graphics with motion, 1080p | -3.7% | -5.5% | -5.6% |
| YUV, text & graphics with motion,720p | -1.5% | -2.7% | -2.9% |
| YUV, mixed content, 1440p | -1.3% | -2.7% | -2.6% |
| YUV, mixed content, 1080p | -1.6% | -4.0% | -4.0% |
| YUV, Animation, 720p | 0.0% | -0.2% | -0.4% |
| YUV, camera captured, 1080p | 0.0% | 0.2% | -0.1% |
| Enc Time[%] | 106% | | |
| Dec Time[%] | 99% | | |
|  |  |  |  |
|  | **Low delay B** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p | -4.0% | -5.4% | -5.2% |
| RGB, text & graphics with motion,720p | -1.2% | -2.3% | -2.2% |
| RGB, mixed content, 1440p | -1.4% | -2.0% | -2.1% |
| RGB, mixed content, 1080p | -1.3% | -2.7% | -2.4% |
| RGB, Animation, 720p | 0.0% | 0.2% | 0.0% |
| RGB, camera captured, 1080p | 0.0% | 0.0% | 0.1% |
| YUV, text & graphics with motion, 1080p | -3.7% | -5.4% | -5.3% |
| YUV, text & graphics with motion,720p | -1.1% | -2.1% | -2.7% |
| YUV, mixed content, 1440p | -1.2% | -2.4% | -2.1% |
| YUV, mixed content, 1080p | -1.2% | -4.3% | -5.2% |
| YUV, Animation, 720p | 0.1% | -0.3% | -0.1% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.2% |
| Enc Time[%] | 105% | | |
| Dec Time[%] | 99% | | |

Table 3. Average BD rate reduction for test A lossless coding compared with CE2 anchors

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **All Intra** | | | |
|  | Bit-rate saving (Total) | Bit-rate saving (Average) | Bit-rate saving (Min) | Bit-rate saving (Max) |
|  |
| RGB, text & graphics with motion, 1080p | 2.8% | 2.8% | 2.5% | 3.0% |
| RGB, text & graphics with motion,720p | 0.6% | 0.7% | 0.1% | 1.2% |
| RGB, mixed content, 1440p | 1.9% | 1.7% | 0.3% | 3.0% |
| RGB, mixed content, 1080p | 1.6% | 1.6% | 1.6% | 1.6% |
| RGB, Animation, 720p | 0.0% | 0.0% | 0.0% | 0.0% |
| RGB, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, text & graphics with motion, 1080p | 1.8% | 1.7% | 1.0% | 2.4% |
| YUV, text & graphics with motion,720p | 0.5% | 0.6% | 0.1% | 0.9% |
| YUV, mixed content, 1440p | 1.8% | 1.6% | 0.4% | 2.8% |
| YUV, mixed content, 1080p | 1.4% | 1.4% | 1.4% | 1.4% |
| YUV, Animation, 720p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 113% | | | |
| Dec Time[%] | 98% | | | |
|  |  |  |  |  |
|  | **Random Access** | | | |
|  | Bit-rate saving (Total) | Bit-rate saving (Average) | Bit-rate saving (Min) | Bit-rate saving (Max) |
|  |
| RGB, text & graphics with motion, 1080p | 2.6% | 2.6% | 1.9% | 3.2% |
| RGB, text & graphics with motion,720p | 0.2% | 0.4% | 0.1% | 0.8% |
| RGB, mixed content, 1440p | 0.3% | 0.4% | 0.0% | 0.7% |
| RGB, mixed content, 1080p | 0.3% | 0.3% | 0.3% | 0.3% |
| RGB, Animation, 720p | 0.0% | 0.0% | 0.0% | 0.0% |
| RGB, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, text & graphics with motion, 1080p | 2.2% | 2.1% | 1.4% | 2.6% |
| YUV, text & graphics with motion,720p | 0.2% | 0.3% | 0.1% | 0.7% |
| YUV, mixed content, 1440p | 0.3% | 0.3% | 0.0% | 0.6% |
| YUV, mixed content, 1080p | 0.2% | 0.2% | 0.2% | 0.2% |
| YUV, Animation, 720p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 103% | | | |
| Dec Time[%] | 99% | | | |
|  |  |  |  |  |
|  | **Low Delay B** | | | |
|  | Bit-rate saving (Total) | Bit-rate saving (Average) | Bit-rate saving (Min) | Bit-rate saving (Max) |
|  |
| RGB, text & graphics with motion, 1080p | 2.7% | 2.6% | 1.7% | 3.3% |
| RGB, text & graphics with motion,720p | 0.1% | 0.2% | 0.1% | 0.5% |
| RGB, mixed content, 1440p | 0.2% | 0.2% | 0.0% | 0.3% |
| RGB, mixed content, 1080p | 0.1% | 0.1% | 0.1% | 0.1% |
| RGB, Animation, 720p | 0.0% | 0.0% | 0.0% | 0.0% |
| RGB, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, text & graphics with motion, 1080p | 2.2% | 2.2% | 1.3% | 3.1% |
| YUV, text & graphics with motion,720p | 0.1% | 0.2% | 0.0% | 0.6% |
| YUV, mixed content, 1440p | 0.1% | 0.1% | 0.0% | 0.3% |
| YUV, mixed content, 1080p | 0.1% | 0.1% | 0.1% | 0.1% |
| YUV, Animation, 720p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 104% | | | |
| Dec Time[%] | 104% | | | |

# Patent rights declaration(s)

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