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| *Title:* | **Non-SCCE1: Intra block copy hash search enhancement** | | |
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| *Purpose:* | Proposal | | |
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# Abstract

This proposal proposes a refinement with chroma components for intra block copy hash search. In SCM-1.0, the BV refinement with chroma components is only applied in normal BV search, and is not applied in hash search for 8x8 CU IntraBC search. Compared to SCM-1.0 full frame intra block copy anchors, the proposed hash search refinement achieves average BD rate gain up to -0.7%, -0.4%, -0.4% for lossy AI, RA and LDB coding for Y component.

# Introduction

There are two stages in block vector search for 8x8 CU intra block copy in SCM-1.0 [2]. The first stage is the spatial search by applying fast search method within search range, and the search range depends on full frame IntraBC or 2CTU IntraBC configuration. The best four BVs are found based on SAD of luma component, then the refinement using SAD of all three color components [3] is applied to find the best BV. This best BV from the first stage will be treated as initial BV for the searching in the second stage. The second stage is hash based search, which derives a list of candidate blocks based on the 16-bit hash value of current block. The best BV of the second stage is determined based on calculating the SAD of luma component between current block and each candidate block. Figure 1 shows the diagram of existing hash based search algorithm in SCM-1.0. BV\_spatial is the best BV obtained from spatial search. SADY is the SAD of luma component.



Figure . Hash based BV search for 8x8 CU in SCM-1.0 [2]

# Hash based search with refinement

We propose to apply the chroma refinement in hash based search. The diagram is shown in Figure 2. There are two steps in the enhanced hash based search. The first step shown in the left part in Figure 2 to find the best N block vectors with SAD of luma component instead of finding only one best block vector as the existing hash based search does. The second step is to select the best block vector from the candidates found in the first step based on the SAD of all three components, which is shown in the right part in the dashed block of Figure 2. In the simulation, N is set to 4. Those changes compared to Figure 1 are highlighted.



Figure . Hash based BV search with chroma refinement for 8x8 CU

# Simulation results

The compression performance is measured using BD rate compared with SCCE1 anchors, using the SCCE1 test conditions [1]. Table 1 and Table 2 gives the detailed average BD rate reduction for test 3 lossless and lossy coding compared with SCCE1 full frame IntraBC anchors, respectively. The test results with bug fix reported by Canon in SCCE1 test-3.3 are provided as supplementary results with the accompanying spreadsheets.

As shown in Table 1, compared with SCCE1 anchors, the lossless coding achieves total bit-rate saving of 0.2%, 0.2% and 0.2% for the first category (RGB, text & graphics with motion, 1080p) for AI, RA and LDB, respectively. As shown in Table 2, the lossy coding achieves average {Y, U, V} BD rate gain of {-0.6%, -0.8%, -0.7%}, {-0.4%, -0.5%, -0.6%} and {-0.3%, -0.5%, -0.3%} for the first category (RGB, text & graphics with motion, 1080p) for AI, RA and LDB, respectively.

Table 1. Average BD rate reduction for lossless coding compared with SCCE1 full frame IntraBC 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 | 0.2% | 0.2% | 0.1% | 0.2% |
| RGB, text & graphics with motion,720p | 0.1% | 0.1% | 0.0% | 0.1% |
| RGB, mixed content, 1440p | 0.0% | 0.0% | 0.0% | 0.0% |
| 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 | 0.1% | 0.1% | 0.1% | 0.3% |
| YUV, text & graphics with motion,720p | 0.1% | 0.1% | 0.0% | 0.3% |
| YUV, mixed content, 1440p | 0.0% | 0.0% | 0.0% | 0.1% |
| 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[%] | 100% | | | |
|  |  |  |  |  |
|  | **Random Access** | | | |
|  | Bit-rate saving (Total) | Bit-rate saving (Average) | Bit-rate saving (Min) | Bit-rate saving (Max) |
|  |
| RGB, text & graphics with motion, 1080p | 0.2% | 0.1% | 0.1% | 0.2% |
| RGB, text & graphics with motion,720p | 0.0% | 0.0% | 0.0% | 0.1% |
| RGB, mixed content, 1440p | 0.0% | 0.0% | 0.0% | 0.0% |
| RGB, mixed content, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| 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 | 0.2% | 0.1% | 0.1% | 0.2% |
| YUV, text & graphics with motion,720p | 0.0% | 0.0% | 0.0% | 0.1% |
| YUV, mixed content, 1440p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, mixed content, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| 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[%] | 102% | | | |
|  |  |  |  |  |
|  |  |  |  |  |
|  | **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 | 0.2% | 0.1% | 0.0% | 0.2% |
| RGB, text & graphics with motion,720p | 0.0% | 0.0% | 0.0% | 0.0% |
| RGB, mixed content, 1440p | 0.0% | 0.0% | 0.0% | 0.0% |
| RGB, mixed content, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| 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 | 0.2% | 0.1% | 0.0% | 0.2% |
| YUV, text & graphics with motion,720p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, mixed content, 1440p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, mixed content, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| 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[%] | 102% | | | |

Table 2. Average BD rate reduction for lossy coding compared with SCCE1 full frame IntraBC anchors

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All Intra** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p | -0.6% | -0.8% | -0.7% |
| RGB, text & graphics with motion,720p | -0.7% | -0.9% | -0.9% |
| RGB, mixed content, 1440p | -0.2% | -0.2% | -0.2% |
| RGB, mixed content, 1080p | -0.2% | -0.3% | -0.3% |
| RGB, Animation, 720p | 0.0% | 0.0% | 0.0% |
| RGB, camera captured, 1080p | 0.0% | 0.0% | 0.0% |
| YUV, text & graphics with motion, 1080p | -0.4% | -0.7% | -0.7% |
| YUV, text & graphics with motion,720p | -0.6% | -0.9% | -1.0% |
| YUV, mixed content, 1440p | -0.1% | -0.4% | -0.3% |
| YUV, mixed content, 1080p | -0.2% | -0.4% | -0.4% |
| YUV, Animation, 720p | 0.0% | -0.1% | 0.0% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 100% | | |
| Dec Time[%] | 95% | | |
|  |  |  |  |
|  | **Random Access** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p | -0.4% | -0.5% | -0.6% |
| RGB, text & graphics with motion,720p | -0.4% | -0.5% | -0.5% |
| RGB, mixed content, 1440p | -0.2% | -0.2% | -0.2% |
| RGB, mixed content, 1080p | -0.1% | -0.1% | -0.3% |
| RGB, Animation, 720p | 0.0% | -0.1% | 0.0% |
| RGB, camera captured, 1080p | 0.0% | 0.0% | 0.0% |
| YUV, text & graphics with motion, 1080p | -0.2% | -0.5% | -0.6% |
| YUV, text & graphics with motion,720p | -0.2% | -0.6% | -0.6% |
| YUV, mixed content, 1440p | 0.0% | -0.4% | -0.3% |
| YUV, mixed content, 1080p | -0.2% | -0.4% | -0.1% |
| YUV, Animation, 720p | 0.0% | -0.3% | 0.1% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.1% |
| Enc Time[%] | 101% | | |
| Dec Time[%] | 97% | | |
|  |  |  |  |
|  | **Low delay B** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p | -0.3% | -0.5% | -0.3% |
| RGB, text & graphics with motion,720p | -0.4% | -0.2% | -0.3% |
| RGB, mixed content, 1440p | -0.1% | -0.4% | -0.1% |
| RGB, mixed content, 1080p | -0.2% | -0.1% | -0.5% |
| RGB, Animation, 720p | 0.0% | -0.1% | 0.0% |
| RGB, camera captured, 1080p | -0.1% | 0.0% | 0.0% |
| YUV, text & graphics with motion, 1080p | -0.3% | -0.5% | -0.5% |
| YUV, text & graphics with motion,720p | 0.0% | 0.1% | 0.1% |
| YUV, mixed content, 1440p | 0.0% | -0.4% | -0.4% |
| YUV, mixed content, 1080p | 0.0% | -0.5% | 0.3% |
| YUV, Animation, 720p | -0.1% | -0.2% | -0.3% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | -0.1% |
| Enc Time[%] | 100% | | |
| Dec Time[%] | 97% | | |

# Conclusions

In this proposal, we proposed chroma refinement in IntraBC hash search. The simulations results compared to SCCE1 anchors show that the IntraBC coding can be improved for both lossless and lossy coding with these small changes.

# Patent rights declaration(s)

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# References

1. J. Sole, S. Liu, “HEVC Screen Content Coding Core Experiment 1 (SCCE1): Intra Block Copying Extensions”, JCTVC-Q1121, Apr. 2014.
2. R. Joshi, J. Xu, R. Cohen, S. Liu, Z. Ma, Y. Ye, “Screen content coding test model 1 (SCM 1)”, JCTVC-Q1014, Apr. 2014.
3. C. Pang, J. Sole, M. Karczewicz, “Intra block copy with encoder search using chroma component”, JCTVC-Q0175, Apr. 2014.