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| *Title:* | **SCCE3: Test B.9 - BWT-based index grouping** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This proposal reports the simulation results with Burrows-Wheeler transform based index grouping (SCCE3 Test B.9) method for palette coding. The technologies were originally proposed in the response of SCC CfP (JCTVC-Q0037) from InterDigital. The palette index map is reorganized with BWT before coding. Compared to SCCE3 2CTU IntraBC anchors, the proposed technologies achieve average BD rate gain up to -0.7%, -0.5%, -0.4% for lossy AI, RA and LDB coding for Y component excluding categories of animation and camera captured.

# Introduction

Burrows-Wheeler transform based palette index grouping method was first proposed in JCTVC-Q0037 [2]. The Burrows–Wheeler transform (BWT) is used to increase the correlation between adjacent positions in the palette index map. The BWT is applied before encoding the palette index map. After scanning each position as a 1-D index string, this string is fed into the BWT process and the end position is also coded as BWT side-information for decoder side reconstruction. A 1-bit flag for each CU is used to indicate if the BWT is performed or not. The BWT with adaptive scanning methods are also tested. Figure 1 shows an example of forward BWT and inverse BWT.



(a)



(b)

Figure 1. An example of (a) forward BWT and (b) inverse BWT. The “A” represents the end of string.

# Simulation results

The compression performance is measured using BD rate compared with SCCE3 anchors, using the SCCE3 test conditions [1]. Table 1 and Table 2 gives the detailed average BD rate reduction for lossless and lossy coding with BWT based index mapping method compared with SCCE3 2CTU IntraBC anchors, respectively. The full test results are provided with the accompanying spreadsheets for details.

As shown in Table 1, compared with SCCE3 anchors, the lossless coding achieves total bit-rate saving of 1.7%, 0.7% and 0.6% for the 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 {-1.4%, -1.5%, -1.4%}, {-0.7%, -0.8%, -0.7%} and {-0.5%, -0.6%, -0.6%} for the category (RGB, text & graphics with motion, 1080p) for AI, RA and LDB, respectively.

Table 1. Average BD rate reduction for lossless coding compared with SCCE3 2CTU 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 | 1.7% | 1.7% | 1.4% | 2.1% |
| RGB, text & graphics with motion,720p | 1.0% | 1.0% | 0.0% | 1.9% |
| RGB, mixed content, 1440p | 0.2% | 0.2% | 0.1% | 0.4% |
| RGB, mixed content, 1080p | 0.2% | 0.2% | 0.2% | 0.2% |
| 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 | 1.6% | 1.6% | 1.0% | 2.2% |
| YUV, text & graphics with motion,720p | 1.0% | 1.2% | 0.0% | 2.4% |
| YUV, mixed content, 1440p | 0.2% | 0.2% | 0.0% | 0.4% |
| 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[%] | 109% | | | |
| 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 | 0.7% | 0.8% | 0.3% | 1.4% |
| RGB, text & graphics with motion,720p | 0.1% | 0.5% | 0.0% | 1.3% |
| 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 | 0.5% | 0.8% | 0.4% | 1.5% |
| YUV, text & graphics with motion,720p | 0.1% | 0.6% | 0.0% | 1.8% |
| 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[%] | 106% | | | |
| Dec Time[%] | 101% | | | |
|  |  |  |  |  |
|  |  |  |  |  |
|  | **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 | 0.6% | 0.5% | 0.2% | 0.8% |
| RGB, text & graphics with motion,720p | 0.1% | 0.2% | 0.0% | 0.4% |
| 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 | 0.4% | 0.5% | 0.4% | 0.9% |
| YUV, text & graphics with motion,720p | 0.1% | 0.2% | 0.0% | 0.6% |
| 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[%] | 105% | | | |
| Dec Time[%] | 101% | | | |

Table 2. Average BD rate reduction for lossy coding compared with SCCE3 2CTU IntraBC anchors

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All Intra** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p | -1.4% | -1.5% | -1.4% |
| RGB, text & graphics with motion,720p | -1.0% | -1.0% | -1.0% |
| RGB, mixed content, 1440p | -0.3% | -0.2% | -0.2% |
| RGB, mixed content, 1080p | -0.6% | -0.7% | -0.6% |
| 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 | -1.2% | -1.4% | -1.3% |
| YUV, text & graphics with motion,720p | -0.6% | -1.0% | -1.1% |
| YUV, mixed content, 1440p | -0.2% | -0.5% | -0.5% |
| YUV, mixed content, 1080p | -0.4% | -1.4% | -1.2% |
| YUV, Animation, 720p | 0.0% | -0.1% | -0.1% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 108% | | |
| Dec Time[%] | 101% | | |
|  |  |  |  |
|  | **Random Access** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p | -0.7% | -0.8% | -0.7% |
| RGB, text & graphics with motion,720p | -1.0% | -1.0% | -0.9% |
| RGB, mixed content, 1440p | -0.2% | -0.1% | -0.1% |
| RGB, mixed content, 1080p | -0.4% | -0.4% | -0.4% |
| 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 | -0.6% | -0.8% | -0.8% |
| YUV, text & graphics with motion,720p | -0.6% | -0.9% | -1.1% |
| YUV, mixed content, 1440p | -0.1% | -0.4% | -0.5% |
| YUV, mixed content, 1080p | -0.3% | -1.1% | -1.2% |
| YUV, Animation, 720p | 0.0% | 0.0% | -0.2% |
| YUV, camera captured, 1080p | 0.0% | 0.1% | -0.1% |
| Enc Time[%] | 106% | | |
| Dec Time[%] | 99% | | |
|  |  |  |  |
|  | **Low delay B** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p | -0.5% | -0.6% | -0.6% |
| RGB, text & graphics with motion,720p | -0.8% | -0.6% | -0.6% |
| RGB, mixed content, 1440p | -0.4% | -0.2% | -0.3% |
| RGB, mixed content, 1080p | -0.4% | -0.5% | -0.4% |
| 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 | -0.3% | -0.6% | -0.6% |
| YUV, text & graphics with motion,720p | -0.3% | -0.4% | -0.4% |
| YUV, mixed content, 1440p | -0.3% | -0.7% | -1.0% |
| YUV, mixed content, 1080p | -0.5% | -2.7% | -1.7% |
| YUV, Animation, 720p | 0.0% | 0.5% | 0.2% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.2% |
| Enc Time[%] | 105% | | |
| Dec Time[%] | 99% | | |

# Patent rights declaration(s)

**InterDigital Communications, Inc. may have IPR 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).**

# References

1. Y.-W. Huang, P. Onno, R. Joshi, R. Cohen, X. Xiu, Z. Ma, “HEVC Screen Content Core Experiment 3 (SCCE3): Palette mode”, JCTVC-Q1123, Apr. 2014.
2. X. Xiu, C.-M. Tsai, Y. He, Y. Ye, “Description of screen content coding technology proposal by InterDigital”, JCTVC-Q1014, Apr. 2014.