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| *Title:* | **Block vector predictor selection for intra block copy** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

In this contribution, a modified block vector signaling scheme is proposed for the Intra Block Copy (IntraBC) mode. In the IntraBC design in SCM 1.0, the last coded block vector (BV) in a CTU is set as the predictor for a current block vector. When the current block is the first IntraBC-coded block, an initial block vector predictor (BVp) value corresponding to its block size is used. This contribution modifies the BVp selection scheme by signaling index of coded-BV’s that are used for BVp. In the lossy condition, it is reported that XX% for the AI and XX%/XX% for RA/LD gains are achieved by this contribution.

# Introduction

At the 17th JCT-VC meeting, intra block copying schemes based on full frame search such as JCTVC-Q0031 [1] and JCTVC-Q0035 [2] were presented. In this context, the size of BV can be up to frame size. However, the current design of BVp decision in SCM 1.0 which uses the last BV as BVp is not the best in terms of RD performance. This contribution proposes a modified BVp selection scheme which searches the best BVp among decoded BV’s.

# Proposed method

The proposed method proposes two modifications from SCM 1.0 (also JCTVC-O0122 [3]). One is that, for the first IntraBC-coded block in CTU, BVp index is signaled to indicate whether initial predictor value is used or not. When the initial predictor value is not used, a BVp index corresponding to selected BVp is signaled. In this way, an IntraBC-coded block which is not the first in CTU can have BVp that is not the last coded BV, thus it can improve coding efficiency. The other modification is that the number of BVp candidates is increased from 1 (i.e., only the last coded BV is used) up to maximally 128 (index range is 0 ~ 127), and a smaller index number is assigned to a nearer coded BV from current block in decoding order.

## BVp candidate list generation rule

A proposed BVp candidate list is generated as follows. At first, the N last decoded BV’s in a current slice are stored. Note that the maximum size of N is set to 128 in this contribution. The very last decoded BV is allocated to index 0 when a current block is not the first IntraBC block in CTU. However, if the current block is the first IntraBC block in CTU, an initial predictor value which is defined in current IntraBC design is set to index 0 and the last coded BV has index 1. Then, the other decoded BV’s following the last BV are indexed in an inverse decoding order.

Table 1. BVp candidate list

|  |  |  |
| --- | --- | --- |
| **BVp Index** | **BVp value** | |
| **First IntraBC PU in CTU** | **Non-first IntraBC PU in CTU** |
| 0 | initial value | last coded BV |
| 1 | last coded BV | second last coded BV |
| 2 | second last coded BV | third last coded BV |
| … | … | … |
| k | kth last coded BV | k+1th last coded BV |

# Results

The proposed method was implemented on the Screen contents coding software version 1.0. The experiments were simulated under the common conditions for screen content coding tests [4].

## Lossy results

Table 2 shows the results of the proposed method. The proposed method improves coding gains on average XX%.

Table 2. Lossy results of the proposed method



## Lossless results

TBU

Table 3. Lossy results of the proposed method

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **All Intra** | | | |
|  | Bit-rate saving (Total) | Bit-rate saving (Average) | Bit-rate saving (Min) | Bit-rate saving (Max) |
|  |
| RGB, text & graphics with motion, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| 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 | 0.0% | 0.0% | 0.0% | 0.0% |
| 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[%] | 100% | | | |
| 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 | 0.0% | 0.0% | 0.0% | 0.0% |
| 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 | 0.0% | 0.0% | 0.0% | 0.0% |
| 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[%] | 100% | | | |
| Dec Time[%] | 100% | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **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 | 0.0% | 0.0% | 0.0% | 0.0% |
| 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 | 0.0% | 0.0% | 0.0% | 0.0% |
| 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[%] | 100% | | | |
| Dec Time[%] | 100% | | | |

# Syntax change

## Coding unit syntax

|  |  |
| --- | --- |
| coding\_unit( x0, y0, log2CbSize ) { | Descriptor |
| if( transquant\_bypass\_enabled\_flag ) |  |
| **cu\_transquant\_bypass\_flag** | ae(v) |
| if( slice\_type != I ) |  |
| **cu\_skip\_flag**[ x0 ][ y0 ] | ae(v) |
| nCbS = ( 1  <<  log2CbSize ) |  |
| if( cu\_skip\_flag[ x0 ][ y0 ] ) |  |
| prediction\_unit( x0, y0, nCbS, nCbS ) |  |
| else { |  |
| if( intra\_block\_copy\_enabled\_flag ) |  |
| **intra\_bc\_flag**[ x0 ][ y0 ] | ae(v) |
| if( slice\_type != I && !intra\_bc\_flag[ x0 ][ y0 ] ) |  |
| **pred\_mode\_flag** | ae(v) |
| if( CuPredMode[ x0 ][ y0 ] != MODE\_INTRA | | intra\_bc\_flag[ x0 ][ y0 ] | |   log2CbSize = = MinCbLog2SizeY ) |  |
| **part\_mode** | ae(v) |
| if( CuPredMode[ x0 ][ y0 ] = = MODE\_INTRA ) { |  |
| if( PartMode = = PART\_2Nx2N && pcm\_enabled\_flag &&   !intra\_bc\_flag[ x0 ][ y0 ] &&   log2CbSize >= Log2MinIpcmCbSizeY &&  log2CbSize <= Log2MaxIpcmCbSizeY ) |  |
| **pcm\_flag**[ x0 ][ y0 ] | ae(v) |
| if( pcm\_flag[ x0 ][ y0 ] ) { |  |
| while( !byte\_aligned( ) ) |  |
| **pcm\_alignment\_zero\_bit** | f(1) |
| pcm\_sample( x0, y0, log2CbSize ) |  |
| } else if( intra\_bc\_flag[ x0 ][ y0 ] ) { |  |
| bvp\_index( x0, y0, 2) |  |
| mvd\_coding( x0, y0, 2) |  |
| if( PartMode = = PART\_2NxN ) |  |
| bvp\_index( x0, y0 + ( nCbS / 2 ), 2) |  |
| mvd\_coding( x0, y0 + ( nCbS / 2 ), 2) |  |
| else if( PartMode = = PART\_Nx2N ) |  |
| bvp\_index( x0 + ( nCbS / 2 ), y0, 2) |  |
| mvd\_coding( x0 + ( nCbS / 2 ), y0, 2) |  |
| else if( PartMode = = PART\_NxN ) { |  |
| bvp\_index( x0 + ( nCbS / 2 ), y0, 2) |  |
| mvd\_coding( x0 + ( nCbS / 2 ), y0, 2) |  |
| bvp\_index( x0, y0 + ( nCbS / 2 ), 2) |  |
| mvd\_coding( x0, y0 + ( nCbS / 2 ), 2) |  |
| bvp\_index( x0 + ( nCbS / 2 ), y0 + ( nCbS / 2 ), 2) |  |
| mvd\_coding( x0 + ( nCbS / 2 ), y0 + ( nCbS / 2 ), 2) |  |
| } |  |

## Block vector predictor index syntax

|  |  |
| --- | --- |
| bvp\_index( x0, y0, refList ) { | **Descriptor** |
| **bvpindex\_greater0\_flag** | ae(v) |
| if(bvpindex \_greater0\_flag ) |  |
| **bvpindex \_greater1\_flag** | ae(v) |
| if(bvpindex \_greater0\_flag) { |  |
| if(bvpindex \_greater1\_flag) |  |
| **bvpindex\_minus2** | ae(v) |
| } |  |
| } |  |

# Conclusion

This contribution proposes a modified block vector signaling scheme for the Intra Block Copy (IntraBC) by searching the best block vector predictor. The proposed method increases the size of block vector predictor candidates list up to 128 and previously decoded block vectors in a current slice are the entries of the list.

By this method, an average gain of XX% for AI and XX%/XX% for RA/LD is provided in lossy coding. Moreover, en/decoding time increment compared to current design is negligible.

# References

[1] J. Chen, Y. Chen, T. Hsieh, R. Joshi, M. Karczewicz, W.-S. Kim, X. Li, C. Pang, W. Pu, K. Rapaka, J. Sole, L. Zhang, F. Zou, “Description of screen content coding technology proposal by Qualcomm,” JCTVC-Q0031, Valencia, ES, Mar. / Apr. 2014.

[2] B. Li, J. Xu, F. Wu, X. Guo, G. J. Sullivan, “Description of screen content coding technology proposal by Microsoft,” JCTVC-Q0035, Valencia, ES, Mar. / Apr. 2014.

[3] G. Laroche, T. Poirier, C. Gisquet, “AHG5: Vector prediction for Intra Block Copy,” JCTVC-O0122, Geneva, CH, Oct. / Nov. 2013.

[4] H. Yu, R. Cohen, K. Rapaka, J. Xu, “Common conditions for screen content coding tests,” JCTVC-Q1015, Valencia, ES, Mar. / Apr. 2014.

# Patent rights declaration(s)

**Sungkyunkwan University may have current or pending patent rights 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).**