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| *Title:* | **Modified Deblocking Filtering Process for Intra Block Copy (IBC)** | | |
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| *Purpose:* | Proposal | | |
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# Abstract

This contribution proposes a modified deblocking filter considering intra block copy (IBC)-coded blocks both for visual quality improvement and coding gain. Intra block copy is a block matching technique that generates prediction value in a picture using block vector similar to motion compensation of inter-prediction mode. In the SCM-1.0, the IBC mode is employed as a prediction mode and it provides significant bitrate savings for screen content videos. For the deblocking filtering of IBC-coded blocks, the SCM-1.0 regards the IBC block as similar to the conventional intra-coded block. It means that SCM-1.0 sets the boundary strength to 2 on the block boundary of two adjacent blocks when one of the blocks is encoded with IBC regardless of the block vectors of two blocks. However, when the two blocks are encoded with IBC having the same block vector without residual coefficients, there is no discontinuity between two blocks. For this case, we propose to modify the deblocking filter process with a special attention to IBC treated as inter-coded blocks. The experimental results show that the average BD-rate of the proposed algorithm is -0.17% for Low Delay, -0.09% for Random Access, and 0.14% for All Intra configuration under the common test conditions for screen content coding, respectively.

# Introduction

For visual quality improvement with coding gain, High Efficiency Video Coding (HEVC) employs an in-loop deblocking filter on the reconstructed pixels. The deblocking filter of HEVC decides a boundary strength (BS) for each block boundary using the coding context such as prediction modes, coded block flag (CBF), motion vector (MV), and reference index. According to the BS, strong deblocking filtering, weak deblocking filtering, or no filtering is applied to each block boundary. The current software model of Screen Content Coding (SCC), SCM-1.0, decides BS from 0 to 2 as the same to HEVC version-1 which depends on the coding conditions of two adjacent blocks (P and Q). A larger value of BS means that the stronger filtering will be conducted and BS=0 means the filtering will not be applied for two adjacent blocks. As depicted in Fig. 1 for the BS flowchart of current SCM-1.0, it shows intra block copy (IBC) is regarded as identical as intra-coded block. When P or Q are encoded with IBC regardless of the block vector of two blocks, the strongest filtering be applied with BS=2. However, the relatively smaller boundary strengths are given for inter-predicted coding. The blocking artifact caused by both prediction (referred by reference picture and motion vector) and quantization (referred by all zero/non-zero transform coded coefficients) are considered as no filtering (BS=0) or relatively weak filtering (BS=1). In the proposal, deblocking filter process can be modified by considering the IBC case.



Fig 1. Bs decision of SCM\_1.0 deblocking filter

# Proposed deblocking filter for intra block copy

In this contribution, we propose to modify the deblocking filtering process with paying attention to IBC-coded blocks. When two adjacent blocks are coded with IBC, the boundary strength for the deblocking filtering is modified to be set to 0 or 1 (no or weak filtering) rather than 2 (strong filtering). As we mentioned before that the current SCM-1.0 considers the IBC block as similar to the conventional intra-coded block. It means that when one block is encoded with IBC, the SCM-1.0 always conducts the strong deblocking filtering on the block boundary with BS=2 regardless the block vectors of the two adjacent blocks. However, when the two blocks are encoded with IBC having the same block vector without residual coefficients, the discontinuity does not occur between two blocks (no blocking artifacts). In this case, strong filtering is not required on the block boundary of two neighboring blocks.

Table 1 shows comparisons of the BS decision between the conventional DBF and the proposed modified DBF for IBC and Fig. 2 shows the flowchart of the proposed modified deblocking filter for IBC. In this proposed algorithm, when P and Q are encoded with IBC, we regard the block vectors between the two neighboring blocks before conducting the deblocking filtering. If the two IBC-coded blocks have different block vector or residual coefficient, the deblocking filtering with BS=1 is performed on the block boundary of two adjacent blocks. Otherwise, BS is set to 0, if the IBC-coded blocks have the same block vector without residual coefficient. When one block is encoded with IBC and other one is Inter-coded block, the BS is set to 1 on the block boundary of the two adjacent blocks since the reference indices are always different regardless of the residual coefficient. However, the BS is set to 2 like the current deblocking filtering process if one block is IBC-coded block and other block is Intra-coded block.

Table 1. Comparisons of the BS decision

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **P** | **Q** | **Motion** | **Residual** | **Boundary strength** | |
| **SCM-1.0** | **Proposed** |
| Intra | Intra | - | - | 2 | 2 |
| Intra (Inter) | Inter (Intra) | - | - | 2 | 2 |
| Inter | Inter | Equal | None | 0 | 0 |
| Inter | Inter | Not equal | - | 1 | 1 |
| Intra (IBC) | IBC (Intra) | - | - | 2 | 2 |
| Inter (IBC) | IBC (Inter) | - | - | 2 | **1** |
| IBC | IBC | Equal | None | 2 | **0** |
| IBC | IBC | Not equal | - | 2 | **1** |

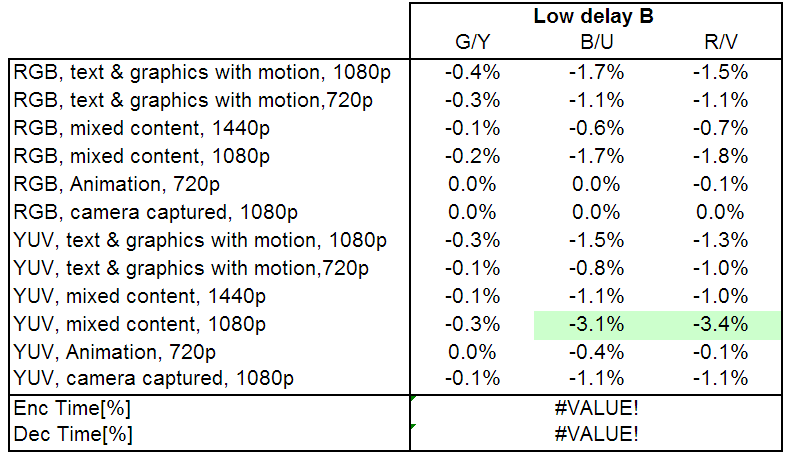


Fig 2. Bs decision of the proposed deblocking filter

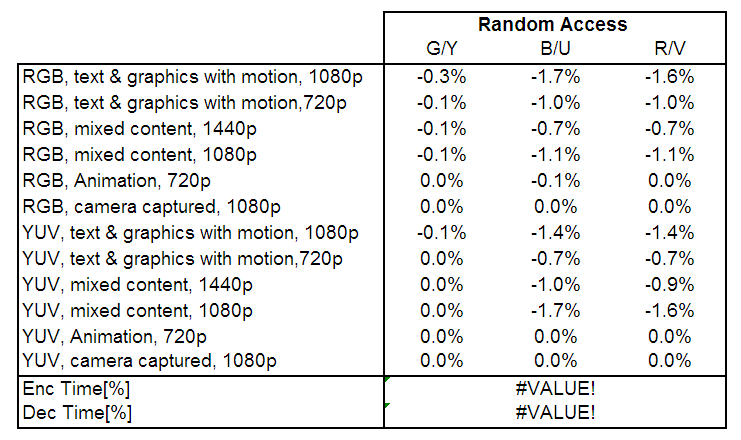
# Experimental results

The proposed method was implemented on HM-14.0+RExt-7.0+SCM-1.0 [1]software and simulated under the recommended test conditions of in-loop filtering “TGM (text and graphics with motion)” cases [2]. The lossy cases are performed to demonstrate the coding efficiency. The summary of lossy BD-Rate performance of the modified deblocking filtering process for IBC in comparison to the SCM\_1.0 is shown in Table 2, Table 3, and Table 4 for Low Delay, Random Access, and All Intra configuration, respectively.

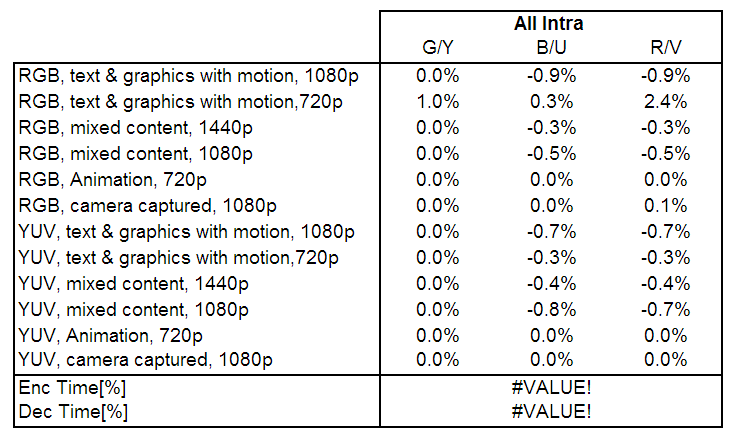
Table 2. Summarized RD-performance of the modified deblocking filter for IBC under Low Delay configuration



**Table 3. Summarized RD-performance of the modified deblocking filter for IBC under Random Access configuration**



**Table 4. Summarized RD-performance of the modified deblocking filter for IBC under All Intra configuration**



# References

1. HM-14.0+RExt-7.0+SCM-1.0 (SCM-1.0), <https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftware/tags/HM-14.0+RExt-7.0+SCM-1.0>
2. H. Yu, R. Cohen, K. Rapaka, and J. Xu, “Common conditions for screen content coding tests, “ JCTVC-Q1015-v2, 17th JCT-VC meeting, Valencia, May., 2014.

# Patent rights declarations

KWU 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).