Modified Deblocking Filtering Process for Intra Block Copy (IBC) (JCTVC-R0118)

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Summary

- Motivation
  - The current deblocking filter is designed inappropriately for IBC-coded block
    - The deblocking filter of SCM-1.0 is conducted with strong filtering for IBC-coded blocks without consideration of the block vector.
    - When two adjacent blocks are coded with IBC mode having same block vector without residual coefficient (means no discontinuity), no blocking artifact exist at the boundary.

- The proposed method
  - Modified deblocking filter for IBC as similar to inter-coded blocks
    - When two adjacent blocks are coded with IBC, boundary strength (Bs) for deblocking filtering is modified to be set to 0 or 1 rather than 2

- Experimental results
  - 0.17% BD-rate gain for Low Delay
  - 0.09% BD-rate gain for Random Access
  - 0.14% BD-rate loss for All Intra

The current DBF process for IBC (1/2)

- Deblocking filter is a tool that is introduced in the previous video standards such as H.264/AVC and HEVC
  - It's designed to reduce blocking artifacts caused by:
    - block-based prediction (intra and inter blocks), and
    - quantization

- In the Screen Content Coding (SCC), intra block copying (IBC) is introduced as a new tool of a prediction mode
  - It provides a significant bitrate savings for SCC

- **Current status**: no body touches the deblocking filter with special attention to the IBC cases for SCC
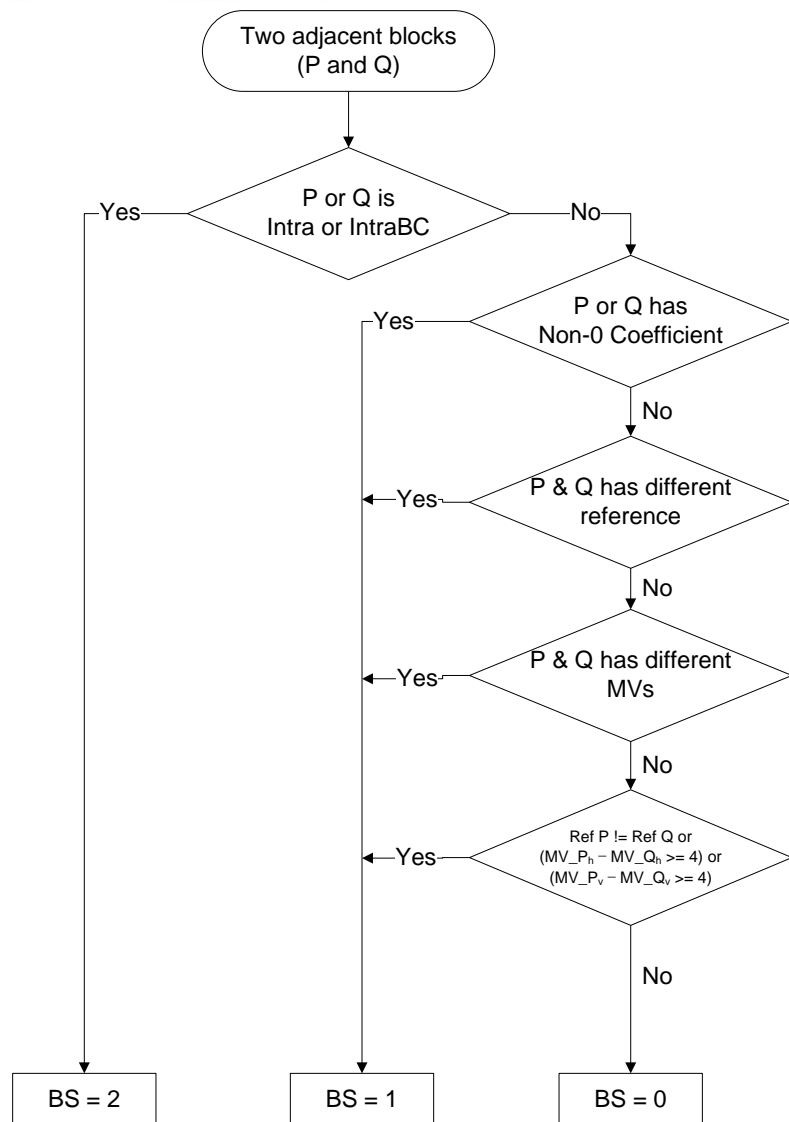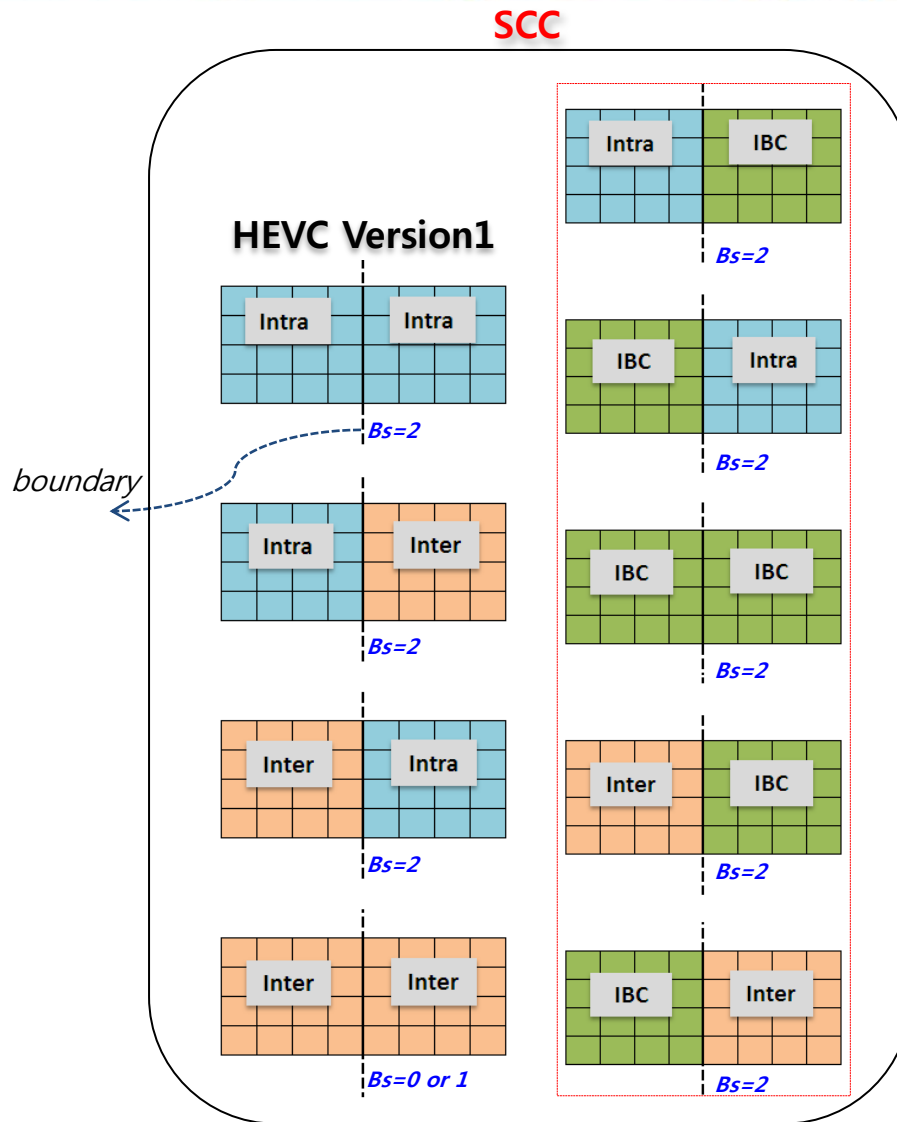
The current DBF process for IBC (2/2)

Fig.1: Current DBF Process Flowchart

Problem statements

- Current SCM-1.0, deblocking filter for IBC is regarded as intra-coded block:

    - It means that boundary strength (Bs) of IBC-coded block is set to 2 *(strong filtering)* regardless of the block vectors of IBC-coded blocks

    - However, when two blocks are encoded with IBC and they have same block vector and no residual coefficients:

        - There is no discontinuity between two blocks
        - Strong filtering is not required to be applied for this case

The proposed modified DBF process for IBC

- Proposed method
  - Deblocking filter is modified with paying attention to IBC-coded blocks as similar to inter-coded blocks
  - Considering the block vectors of two blocks coded with IBC:
    - **Bs=0** *(no filtering)* for two IBC-coded blocks having same block vector without residual coefficient
    - **Bs=1** *(weak filtering)* when two IBC-coded blocks have different block vector or residual coefficient

  - When (P_{IBC} and Q_{Inter}) or (P_{Inter} and Q_{IBC}) :
    - **Bs=1** *(weak filtering)* since reference indices are always different regardless of residual coefficient

  - When (P_{IBC} and Q_{Intra}) or (P_{Intra} and Q_{IBC}) :
    - **Bs=2** *(strong filtering)* as similar with the current deblocking filtering process

Decision of the modified DBF boundary strength

- **The comparisons of the boundary strength (BS) decision between the conventional DBF and the proposed modified DBF for IBC**

Table 1. The 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**

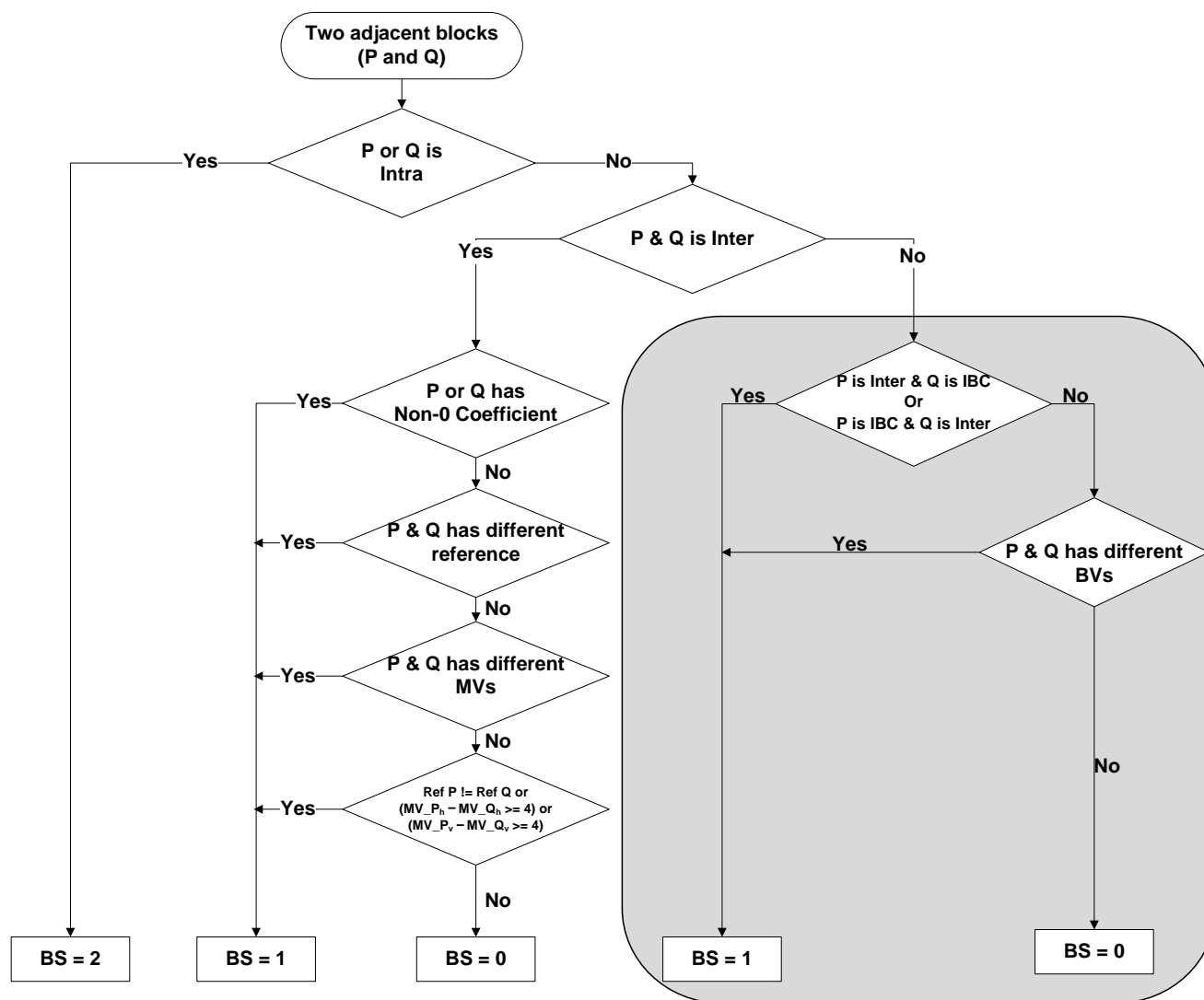# Flowchart of the proposed modified DBF

Fig.2: The proposed modified DBF for IBC process flowchart

Experimental results (1/3)

- BD-rate results of modified DBF for IBC under Low Delay

	Low Delay		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p	-0.44%	-1.75%	-1.55%
RGB, text & graphics with motion,720p	-0.29%	-1.11%	-1.10%
RGB, mixed content, 1440p	-0.13%	-0.64%	-0.67%
RGB, mixed content, 1080p	-0.20%	-1.69%	-1.79%
RGB, Animation, 720p	-0.03%	0.01%	-0.06%
RGB, camera captured, 1080p	-0.01%	0.00%	0.04%
YUV, text & graphics with motion, 1080p	-0.26%	-1.54%	-1.30%
YUV, text & graphics with motion,720p	-0.07%	-0.78%	-1.01%
YUV, mixed content, 1440p	-0.09%	-1.15%	-1.01%
YUV, mixed content, 1080p	-0.26%	-3.10%	-3.43%
YUV, Animation, 720p	-0.04%	-0.36%	-0.13%
YUV, camera captured, 1080p	-0.12%	-1.05%	-1.06%
All	-0.17%	-1.01%	-1.00%

Experimental results (2/3)

- BD-rate results of modified DBF for IBC under Random Access

	Random Access		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p	-0.31%	-1.67%	-1.58%
RGB, text & graphics with motion,720p	-0.11%	-1.03%	-1.03%
RGB, mixed content, 1440p	-0.11%	-0.70%	-0.75%
RGB, mixed content, 1080p	-0.11%	-1.08%	-1.12%
RGB, Animation, 720p	-0.05%	-0.08%	-0.02%
RGB, camera captured, 1080p	-0.02%	-0.02%	0.01%
YUV, text & graphics with motion, 1080p	-0.12%	-1.35%	-1.37%
YUV, text & graphics with motion,720p	-0.03%	-0.68%	-0.71%
YUV, mixed content, 1440p	0.02%	-0.97%	-0.88%
YUV, mixed content, 1080p	-0.04%	-1.69%	-1.57%
YUV, Animation, 720p	0.01%	-0.04%	0.00%
YUV, camera captured, 1080p	-0.01%	-0.02%	-0.02%
All	-0.09%	-0.86%	-0.84%

Experimental results (3/3)

- BD-rate results of modified DBF for IBC under All Intra

	All Intra		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p	-0.04%	-0.85%	-0.86%
RGB, text & graphics with motion, 720p	0.97%	0.30%	2.41%
RGB, mixed content, 1440p	-0.04%	-0.29%	-0.35%
RGB, mixed content, 1080p	-0.03%	-0.50%	-0.52%
RGB, Animation, 720p	0.01%	0.03%	0.02%
RGB, camera captured, 1080p	0.00%	0.02%	0.06%
YUV, text & graphics with motion, 1080p	-0.02%	-0.68%	-0.67%
YUV, text & graphics with motion, 720p	0.01%	-0.28%	-0.28%
YUV, mixed content, 1440p	-0.02%	-0.42%	-0.43%
YUV, mixed content, 1080p	0.00%	-0.78%	-0.73%
YUV, Animation, 720p	0.01%	0.02%	-0.01%
YUV, camera captured, 1080p	0.00%	0.01%	0.03%
All	0.14%	-0.27%	0.05%

Conclusion

- The modified deblocking filter for intra block copy (IBC) is proposed with consideration of coded modes of two neighboring blocks

- The proposed method achieves:
    - 0.17% BD-rate gain for Low Delay
    - 0.09% BD-rate gain for Random Access
    - 0.14% BD-rate lost for All Intra
    - Under the common test condition of SCC

- It is recommended to adopt the proposed method into SCC