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JCTVC-F318

On the precision of interpolation processing

Takeishi Chujoh
Tomoo Yamakage

TOSHIBA CORPORATION

July 14-22, 2011

Problems

- **Regarding interpolation process, there are some differences between WD and HM software. In JCTVC-D321, there is no intermediate rounding of interpolation process and HM software does not include intermediate rounding in case of single prediction. However WD includes some intermediate rounding because of integration of JCTVC-D321.**
- **Since pixel variable of HM software is defined by 16-bit short integer, it is possible to cause overflow in case of B-Slice.**

Recommend solution

- **Remove intermediate rounding and clipping.**
 - Since the precision of both luma and chroma filter coefficients are 6-bit and maximum input bit-depth is 14-bit, if there is no intermediate rounding, all interpolation processes don't overflow on signed 32-bit integer.
 - Although 16-bit architecture is ideal, filter coefficients and tap-length are under consideration in CE3.
 - If there is no intermediate rounding, it is possible to change order of operations and introduce flexible implementation for different architectures.

Test Results

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.0	0.0	-0.3	0.0	-0.1	0.2
Class B	0.0	0.0	0.0	0.0	0.0	0.0
Class C	0.0	0.0	0.0	0.0	0.0	0.0
Class D	0.0	0.0	-0.1	0.0	0.0	0.0
Class E						
Overall	0.0	0.0	-0.1	0.0	0.0	0.1
Enc Time[%]	100%			99%		
Dec Time[%]	99%			98%		

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.0	0.0	-0.3	0.0	-0.2	-0.3
Class C	0.0	-0.1	-0.1	0.0	0.0	-0.2
Class D	0.0	0.0	0.0	0.0	0.1	-0.2
Class E	0.0	0.3	-0.8	-0.1	-0.2	-0.2
Overall	0.0	0.0	-0.3	0.0	-0.1	-0.2
Enc Time[%]	100%			100%		
Dec Time[%]	99%			98%		

Performance is not chanded

Changeable order specially

- **Considering the interpolation processing based on MC block, if the block is rectangle, not square, the number of operation and intermediate pixels is different to the order.**
- **If the block is horizontally long, the order of vertical filtering and horizontal filtering is better.**
- **If the block is vertically long, the order of horizontal filtering and vertical filtering is better.**

Changeable order temporally

- If MVs of both list 0 and 1 indicate same fractional position, firstly two pixel values are added and then those values can be filtered. As a result, about half operations can be achieved.

$$f_q[] = \{-1, 4, -10, 57, 19, -7, 3, -1\}$$

$$\text{predictionSamplesL0}_e + \text{predictionSamplesL1}_e$$

$$= \sum_{i=-3}^4 \sum_{j=-3}^4 f_q[i] f_q[j] A_{0,i,j} + \sum_{i=-3}^4 \sum_{j=-3}^4 f_q[i] f_q[j] A_{1,i,j}$$

$$= \sum_{i=-3}^4 \sum_{j=-3}^4 f_q[i] f_q[j] (A_{0,i,j} + A_{1,i,j})$$

Conclusion

- **Although there are several solutions, we would like to recommend that all intermediate rounding and clipping of interpolation processing should be removed at this point.**
- **The design of rounding and clipping should be discussed after the design of interpolation processing has been finished.**
- **Cross-checked by JCTVC-F637 (Sony)**

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