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Title: **Simplification of chroma deblocking filter in JCTVC-F118**

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Purpose: Proposal

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Abstract

A modified chroma deblocking filter is proposed in JCTVC-F118, where the filtering unit size for chroma is determined according to the sampling format. Moreover, filtering decision is also added for chroma boundary. This contribution is to simplify the chroma filtering decision in JCTVC-F118 by reusing the filtering decision results of luma component. It is reported that on average BD-Rate reductions of 1.7%, 2.9%, 2.9%, 3.2%, 2.9% and 3.5% are achieved for HE-AI, LC-AI, HE-RA, LC-RA, HE-LD and LC-LD, respectively. The results are reported to be similar to that of JCTVC-F118. It is also reported that the decoding time of proposed method is slightly reduced compared with that of JCTVC-F118 and HM 3.0, and the subjective quality is almost the same to that of JCTVC-F118.

1 Introduction

In HM3.0 deblocking filter, filtering decision is only applied on luma boundaries. In order to further improve both objective performance and subjective quality, we have proposed a chroma filtering decision strategy in our previous proposal [1]. In [1], chroma boundaries use the same filtering decision method with luma boundaries except that 2 pixels in each side of a chroma boundary are used instead of 4. In [2], the same strategy is also proposed. Although the running time is not increased, there would be potential increase for the complexity of chroma deblocking filter. To further reduce the complexity, we propose to reuse the filtering decision results of luma.

The rest of this contribution is organized as follows. Section 2 describes the proposed algorithm. Section 3 shows and analyzes the experimental results. And section 4 draws our conclusion.

2 Algorithm Description

In [2], the filtering decisions for luma and chroma components are calculated and stored separately. Considering that the corresponding luma and chroma components may have high correlations, we propose to use a simplified the chroma filtering decision by reusing the filtering decision results of luma.

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2.1 Chroma Filtering Decision

Figure 1 gives the flowchart of the proposed method, where the entry condition is BS>0. Beta_Luma and Beta_Chroma are the threshold values got from the beta table for luma and chroma, respectively. The luma pixel difference *d* is defined as follows:

$$d = |p2_2 - 2*p1_2 + p0_2| + |q2_2 - 2*q1_2 + q0_2| + |p2_5 - 2*p1_5 + p0_5| + |q2_5 - 2*q1_5 + q0_5 . \quad (1)$$

The chroma samples will be filtered if the below expression is true:

$$(d < \text{Beta_Chroma}) \;\&\&\; (BS>1). \quad (2)$$

Note that Beta_Luma is exactly the same as in HM 3.0, and Beta_Chroma is defined according to the slice type:

1) For I slices, Beta_Chroma is defined as twice the QP value for luma.
2) For B/P slices, Beta_Chroma is the same as Beta_Luma.

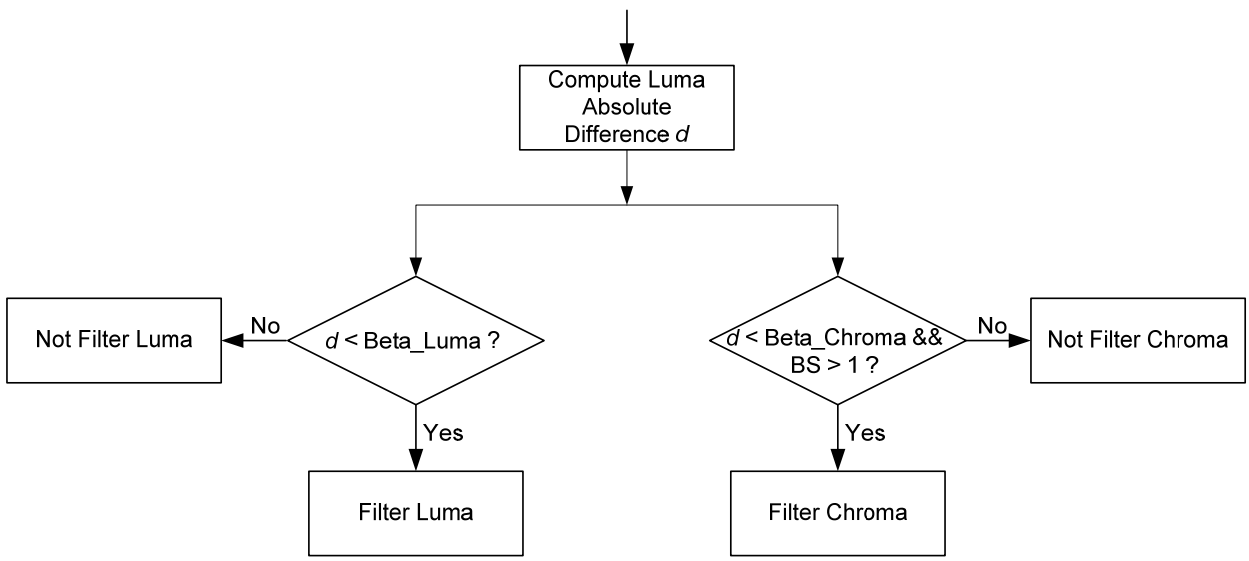

Figure 1. Flowchart of the proposed method

2.2 Chroma Filtering Operation

The chroma filtering operation is the same as that in [2]. Specifically, the *delta* value is defined as:

$$delta = \text{Clip}(-tc, tc, (12*(q0-p0) + 3*(p1-q1) + 16) >> 5. \quad (3)$$

After that, p0 and q0 will be modified as

$$p0' = \text{Clip}(p0+delta)$$
$$q0' = \text{Clip}(q0-delta),$$

where *tc* is the clipping value got from the TC Table.

3 Experimental Results

3.1 Coding Performance

Our simulation is based on HM3.0 software and the recommended test conditions in [3]. Table 1 and Table 2 give the coding performance of [2] and the proposed method compared to HM 3.0, respectively. In summary, the average BD-Rate reductions of 1.7%, 2.9%, 2.9%, 3.2%, 2.9% and 3.5% are achieved

for HE-AI, LC-AI, HE-RA, LC-RA, HE-LD and LC-LD respectively, which is very similar to the coding performance in [2].

Table 1. Performance of JCTVC-F118 compared to HM 3.0

	HE-AI			LC-AI		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-1.60%	-1.49%	-1.20%	-1.28%	-2.33%	-2.06%
Class B	-1.21%	-1.44%	-1.65%	-1.03%	-2.63%	-2.73%
Class C	-0.94%	-2.45%	-2.46%	-0.93%	-3.40%	-3.90%
Class D	-0.87%	-2.26%	-2.45%	-0.84%	-3.55%	-3.83%
Class E	-1.28%	-0.40%	-0.57%	-1.14%	-2.24%	-3.03%
All	-1.18%	-1.66%	-1.72%	-1.04%	-2.85%	-3.09%
Enc Time		N/A			N/A	
Dec Time		100.43%			102.05%	

	HE-RA			LC-RA		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-1.40%	-2.33%	-1.79%	-1.36%	-2.60%	-2.00%
Class B	-1.24%	-2.62%	-2.30%	-1.28%	-2.81%	-2.31%
Class C	-0.98%	-3.50%	-3.30%	-1.00%	-3.51%	-3.81%
Class D	-0.77%	-2.86%	-3.30%	-0.76%	-2.91%	-3.04%
Class E						
All	-1.11%	-2.82%	-2.65%	-1.11%	-2.95%	-2.76%
Enc Time		N/A			N/A	
Dec Time		100.11%			102.65%	

	HE-LD			LC-LD		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	-1.43%	-2.66%	-2.75%	-1.36%	-2.42%	-2.26%
Class C	-1.07%	-2.91%	-2.84%	-0.99%	-2.35%	-2.95%
Class D	-0.90%	-1.75%	-1.79%	-0.82%	-1.66%	-2.30%
Class E	-2.76%	-3.05%	-3.74%	-2.43%	-6.59%	-6.24%
All	-1.46%	-2.57%	-2.72%	-1.33%	-3.00%	-3.19%
Enc Time		N/A			N/A	
Dec Time		99.48%			102.89%	

Table 2. Performance of proposed algorithm compared to HM 3.0

	HE-AI			LC-AI		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-1.60%	-1.75%	-1.44%	-1.28%	-2.71%	-2.42%
Class B	-1.21%	-1.64%	-1.71%	-1.03%	-3.04%	-3.06%
Class C	-0.94%	-2.33%	-2.25%	-0.93%	-3.36%	-3.41%
Class D	-0.85%	-2.10%	-2.10%	-0.84%	-3.05%	-3.06%
Class E	-1.28%	-0.34%	-0.50%	-1.14%	-1.61%	-2.46%
All	-1.17%	-1.70%	-1.66%	-1.04%	-2.83%	-2.91%
Enc Time		N/A			N/A	
Dec Time		99.60%			100.27%	

	HE-RA			LC-RA		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-1.41%	-2.91%	-2.49%	-1.42%	-3.42%	-2.58%
Class B	-1.25%	-3.04%	-2.66%	-1.28%	-3.58%	-3.07%
Class C	-0.98%	-3.20%	-2.97%	-0.98%	-3.47%	-3.26%
Class D	-0.79%	-2.64%	-2.50%	-0.74%	-3.10%	-2.94%
Class E						
All	-1.12%	-2.96%	-2.65%	-1.11%	-3.40%	-2.97%
Enc Time		N/A			N/A	
Dec Time		98.44%			100.11%	

	HE-LD			LC-LD		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	-1.46%	-3.10%	-3.01%	-1.37%	-3.41%	-3.01%
Class C	-1.07%	-3.10%	-2.94%	-0.99%	-2.64%	-2.80%
Class D	-0.89%	-1.98%	-1.75%	-0.87%	-2.49%	-2.35%
Class E	-2.84%	-3.86%	-4.04%	-2.39%	-6.26%	-6.10%
All	-1.48%	-2.96%	-2.87%	-1.34%	-3.52%	-3.37%
Enc Time		N/A			N/A	
Dec Time		98.12%			100.23%	

3.2 Consistency Statistics

Table 3 gives consistency statistics based on [2]. The percentage values indicate the ratios that chroma boundaries have the same filtering decision results as corresponding luma boundaries. It can be seen that 74.88% of the U boundaries and 74.41% of the V boundaries have the same filtering on/off decision as the corresponding luma boundaries.

Table 3. Consistency statistics of luma and chroma

	HE-AI			LC-AI		
	Y Perc.	U Perc.	V Perc.	Y Perc.	U Perc.	V Perc.
Class A	N/A	81.38%	81.47%	N/A	81.01%	80.86%
Class B	N/A	77.91%	77.16%	N/A	78.85%	78.12%
Class C	N/A	70.46%	69.28%	N/A	70.67%	69.38%
Class D	N/A	62.08%	61.35%	N/A	62.73%	61.95%
Class E	N/A	86.43%	86.73%	N/A	86.16%	86.47%
All	N/A	75.23%	74.72%	N/A	75.52%	74.94%

	HE-RA			LC-RA		
	Y Perc.	U Perc.	V Perc.	Y Perc.	U Perc.	V Perc.
Class A	N/A	83.12%	83.00%	N/A	82.29%	82.02%
Class B	N/A	78.90%	78.22%	N/A	79.41%	78.78%
Class C	N/A	72.04%	71.16%	N/A	72.12%	71.27%
Class D	N/A	62.77%	61.98%	N/A	63.04%	62.32%
Class E						
All	N/A	74.48%	73.86%	N/A	74.52%	73.91%

	HE-LD			LC-LD		
	Y Perc.	U Perc.	V Perc.	Y Perc.	U Perc.	V Perc.
Class A						
Class B	N/A	80.41%	79.87%	N/A	79.70%	79.11%
Class C	N/A	72.85%	72.07%	N/A	72.62%	71.91%
Class D	N/A	64.91%	64.79%	N/A	64.17%	64.24%
Class E	N/A	83.29%	83.66%	N/A	81.42%	82.24%
All	N/A	75.19%	74.86%	N/A	74.37%	74.18%

4 Conclusion

In this contribution, a simplification to the chroma filtering decision in [2] has been proposed. Specifically, the filtering decision results of luma are reused and the boundary strength values for chroma are removed. The average coding performance is similar to that of [2] whereas the required computations and memory storages are essentially less. Statistics also show that the joint filtering decision for luma and chroma is reasonable. We propose to include this technique into core experiment.

5 References

[1] J. An, Q. Huang, X. Guo, Y.-W. Huang and S. Lei, "CE12 Subtest1: Improved Deblocking Filter," JCTVC-E079, 5th JCTVC meeting, Geneva, CH, March 2011.

[2] "CE12: Deblocking filter proposed by Ericsson and MediaTek," JCTVC-F118, 6th JCTVC meeting, Torino, IT, July 2011.

[3] Frank Bossen, "Common test conditions and software reference configurations", JCTVC-E700, 5th JCT-VC meeting, Geneva, CH, March 2011.

6 Patent rights declaration(s)

MediaTek Inc. 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

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