

JVET-M0162: Adaptive loop filter with a maximum number of luma filters per slice constraint

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Overall Summary

- In ALF, up to 25 luma filters can be used in one slice, which requires one on-chip memory with size equal to 2600 bits
- Add a maximum number of luma filters per slice constraint to reduce the on-chip memory
- Reported BD-rate numbers:

	Luma BD-rate Over VTM-3.0			On-Chip Memory
	AI	RA	LB	
16 filters at most	0.00%	0.00%	0.00%	64%
12 filters at most	0.01%	0.01%	-0.01%	48%

Current Design of ALF

- Block-based filter adaptation is supported in ALF
 - One slice is partitioned into several 4x4 blocks
 - Each 4x4 block is classified into one of 25 groups
- Sharing one filter between different groups is allowed
 - In the worst case, up to 25 filters can be used
- Switching filters one 4x4 block by one 4x4 block needs one on-chip memory to store all luma filter coefficients
 - The size is $25 \text{ filters} \times 13 \text{ coeff./filter} \times 8\text{bits/coeff.} = 2600 \text{ bits}$

Proposed Method

- The maximum number of luma filters per slice is constrained to reduce the on-chip memory usage
 - Merge some groups to share one filter
 - The on-chip memory usage can be reduced

# of filters per slice	25 filters	16 filters	12 filters
On-chip memory size	2600 bits	1664 bits	1248 bits

Simulation Results of 16 Filters Per Slice

		All Intra Main10				
		Over VTM-3.0				
		Y	U	V	EncT	DecT
	Class A1	0.00%	0.00%	0.00%	100%	101%
	Class A2	0.00%	-0.01%	-0.01%	100%	102%
	Class B	0.00%	0.00%	0.00%	101%	104%
	Class C	0.00%	0.00%	0.00%	100%	100%
	Class E	0.00%	0.00%	0.00%	100%	101%
	Overall	0.00%	0.00%	0.00%	100%	102%
	Class D	0.00%	0.00%	0.00%	101%	100%
	Class F	0.00%	-0.01%	-0.01%	101%	101%
		Random Access Main 10				
		Y	U	V	EncT	DecT
	Class A1	0.00%	-0.01%	0.04%	100%	100%
	Class A2	0.00%	0.05%	0.05%	100%	98%
	Class B	0.01%	0.01%	-0.02%	100%	100%
	Class C	0.00%	0.00%	0.00%	100%	101%
	Overall	0.00%	0.01%	0.01%	100%	100%
	Class D	0.00%	0.00%	0.00%	100%	100%
	Class F	-0.01%	-0.01%	0.00%	100%	100%
		Low delay B Main10				
		Y	U	V	EncT	DecT
	Class B	0.00%	0.02%	0.05%	100%	100%
	Class C	0.00%	0.01%	0.03%	100%	100%
	Class E	0.00%	-0.02%	-0.02%	100%	100%
	Overall	0.00%	0.00%	0.02%	100%	100%
	Class D	-0.02%	-0.03%	0.13%	101%	101%
	Class F	0.00%	-0.03%	0.03%	100%	100%

Simulation Results of 12 Filters Per Slice

		All Intra Main10				
		Over VTM-3.0				
		Y	U	V	EncT	DecT
	Class A1	0.01%	-0.01%	-0.01%	100%	99%
	Class A2	0.02%	-0.02%	-0.02%	100%	100%
	Class B	0.01%	-0.02%	-0.02%	100%	100%
	Class C	0.00%	-0.01%	-0.01%	100%	101%
	Class E	0.00%	-0.01%	-0.01%	100%	101%
	Overall	0.01%	-0.01%	-0.01%	100%	100%
	Class D	0.00%	0.00%	0.00%	100%	101%
	Class F	0.01%	-0.02%	-0.02%	100%	101%
		Random Access Main 10				
		Y	U	V	EncT	DecT
	Class A1	0.00%	-0.06%	-0.06%	100%	100%
	Class A2	0.01%	0.13%	0.06%	100%	98%
	Class B	0.01%	0.12%	-0.03%	100%	100%
	Class C	0.00%	0.01%	0.01%	100%	100%
	Overall	0.01%	0.06%	-0.01%	100%	100%
	Class D	0.00%	0.00%	0.00%	100%	101%
	Class F	0.00%	-0.01%	0.04%	101%	100%
		Low delay B Main10				
		Y	U	V	EncT	DecT
	Class B	0.00%	-0.30%	0.08%	100%	101%
	Class C	-0.01%	0.09%	0.07%	100%	100%
	Class E	0.00%	-0.02%	0.08%	100%	100%
	Overall	-0.01%	-0.10%	0.08%	100%	100%
	Class D	-0.01%	0.01%	-0.21%	100%	100%
	Class F	-0.03%	0.11%	0.02%	101%	100%

Conclusions

- In ALF, up to 25 luma filters can be used in one slice
- Add a maximum number of luma filters per slice constraint to reduce the on-chip memory
- Reported BD-rate number

	Luma BD-rate Over VTM-3.0			On-Chip Memory
	AI	RA	LB	
25 filters (VTM3.0)	-	-	-	2600 bits
16 filters at most	0.00%	0.00%	0.00%	1664 bits
12 filters at most	0.01%	0.01%	-0.01%	1248 bits

- Thank Kwai for cross-checking the results.



On-Chip Memory Usage with Filter Selection

- Current design
 - Filter coefficients: $25 \text{ luma filters} \times 13 \text{ coefficients per filter} \times 8 \text{ bits per coefficients} = 2600 \text{ bits}$
 - Filter selection: $5 \text{ bits per group} \times 25 \text{ groups} = 125 \text{ bits}$ (may not be necessary)
 - Total 2600 bits or 2725 bits
- Proposed
 - Filter coefficients: $12 \text{ luma filters} \times 13 \text{ coefficients per filter} \times 8 \text{ bits per coefficients} = 1248 \text{ bits}$
 - Filter selection: $4 \text{ bits per group} \times 25 \text{ groups} = 100 \text{ bits}$ (required)
 - Total 1348 bits