AHG6: ALF with non-normative encoder-only improvements

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Overall Summary

- Non-normative encoder-only improvements
  - More accurate rate estimation in RDO process
  - Try up to eight previous APS

- Bug-fix of ticket #574 (mismatch between software and text)
  - Swap coef[2] and coef[4] in the bitstream in software
  - BD-rate = 0% for this fix

- Compared to HM-7.0 ALF
  - 0.3% - 1.1% BD-rate reductions for CTC sequences
  - 0.4% - 2.4% BD-rate reductions for KTA sequences

- Compared to ALF-off

Anchor: ALF-off	Luma BD-rate in Main Conditions				Luma BD-rate in HE10 Conditions			
	AI	RA	LDB	LDP	AI	RA	LDB	LDP
CTC Sequences	-1.6%	-3.1%	-2.3%	-3.6%	-1.8%	-3.3%	-2.6%	-4.5%
KTA Sequences	-2.5%	-4.3%	-3.8%	-9.0%	-2.6%	-4.6%	-4.3%	-10.7%

Proposed Encoder-Only Improvements

HM7.0 ALF

Cur. Pic. Statistics
(High Efficiency Mode)

Pre. Pic. Statistics
(Low Latency Mode)
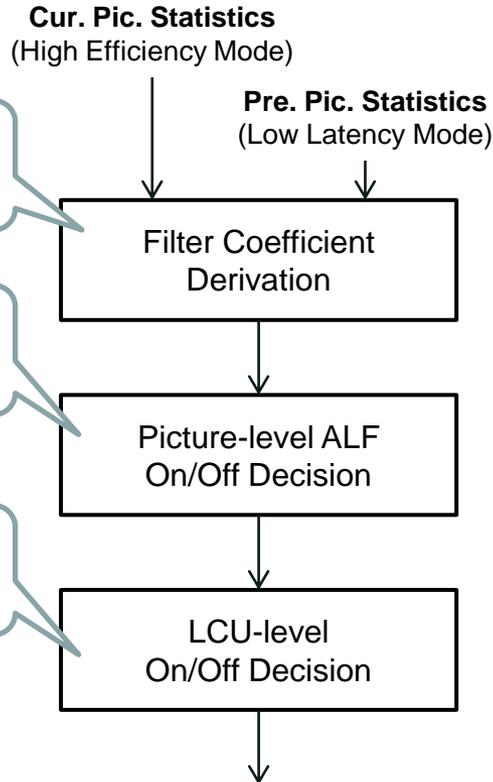
1 iteration in filter coefficient redesign *(HE mode only)*

Filter Coefficient Derivation

Only filter coeff. bits are considered

Picture-level ALF On/Off Decision

Using CAVLC in RDO

LCU-level On/Off Decision

Proposed

Cur. Pic. Statistics
(High Efficiency Mode)

Pre. Pic. Statistics
(Low Latency Mode)
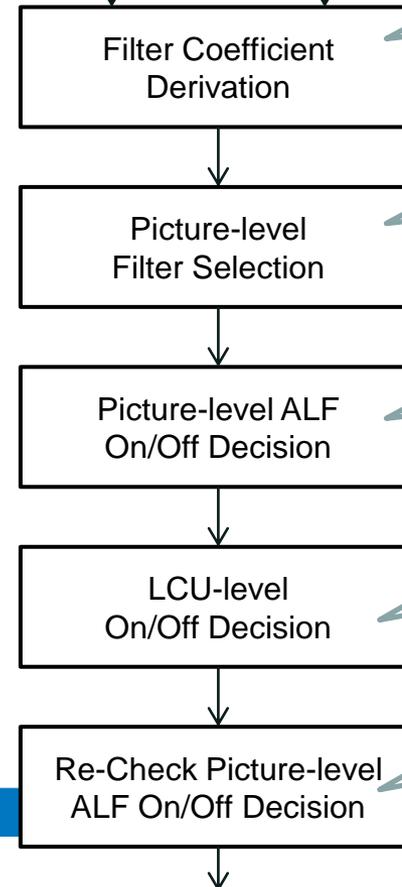
3 iterations in filter coefficient redesign *(HE mode only)*

Filter Coefficient Derivation

Try up to 8 previous APS

Picture-level Filter Selection

Filter coeff. bits + LCU on/off flags are considered

Picture-level ALF On/Off Decision

Using CABAC in RDO

LCU-level On/Off Decision

Check alf on/off decision again *(HE mode only)*

Re-Check Picture-level ALF On/Off Decision

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Summary of Improvements

- Consider the rate of LCU on/off control flags during picture-level on/off decision

- Use CABAC for rate estimation of LCU on/off control flags during LCU on/off decision

- Reuse up to eight previous adaptation parameter sets during picture-level filter selection

- Recheck picture-level ALF-off after LCU on/off decisions (only for high efficiency mode)

- Increase from one to three redesigns of filter coefficients (only for high efficiency mode)

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Simulation Results, CTC Sequences

- Using common test condition (CTC) sequences

- LL: low latency mode; HE: high efficiency mode

CTC	HM-7.0 OLD LL			HM-7.0 NEW LL			HM-7.0 OLD HE			HM-7.0 NEW HE		
BD-rate	Y(%)	Cb(%)	Cr(%)	Y(%)	Cb(%)	Cr(%)	Y(%)	Cb(%)	Cr(%)	Y(%)	Cb(%)	Cr(%)
M-AI	-1.3	-2.7	-3.0	-1.6	-2.7	-2.9	-1.3	-3.0	-3.2	-1.6	-3.1	-3.3
M-RA	-2.2	-2.4	-2.3	-2.7	-1.9	-1.7	-2.6	-2.6	-2.5	-3.1	-2.5	-2.3
M-LB	-1.2	-3.0	-3.1	-1.9	-2.3	-2.2	-1.3	-2.9	-3.1	-2.3	-3.0	-3.1
M-LP	-2.5	-4.2	-4.1	-3.2	-3.3	-3.0	-2.5	-4.0	-3.8	-3.6	-4.1	-4.0
H-AI	-1.4	-3.9	-4.2	-1.7	-3.7	-4.2	-1.5	-4.1	-4.6	-1.8	-4.2	-4.6
H-RA	-2.4	-3.8	-3.9	-2.8	-3.0	-3.1	-2.9	-4.3	-4.4	-3.3	-4.0	-4.1
H-LB	-1.6	-4.4	-4.6	-2.2	-3.3	-3.2	-2.0	-4.6	-4.6	-2.6	-4.6	-4.5
H-LP	-3.4	-6.2	-6.1	-3.9	-4.6	-4.4	-3.8	-6.2	-6.0	-4.5	-6.2	-6.2
Avg.	-2.0	-3.8	-3.9	-2.5	-3.1	-3.1	-2.2	-4.0	-4.0	-2.9	-4.0	-4.0

Encoding Latency = 1 LCU

Encoding Latency = 1 Picture

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Simulation Results, KTA Sequences

- 15 720p and 10 1080p sequences that were commonly seen during key technical area (KTA) software study period

KTA	HM-7.0 OLD LL			HM-7.0 NEW LL			HM-7.0 OLD HE			HM-7.0 NEW HE		
BD-rate	Y(%)	Cb(%)	Cr(%)	Y(%)	Cb(%)	Cr(%)	Y(%)	Cb(%)	Cr(%)	Y(%)	Cb(%)	Cr(%)
M-AI	-2.1	-3.0	-2.9	-2.4	-2.9	-2.7	-2.2	-3.2	-3.1	-2.5	-3.2	-3.3
M-RA	-2.5	-3.4	-2.9	-3.2	-2.5	-2.2	-3.1	-3.8	-3.2	-4.3	-3.4	-3.0
M-LB	-2.0	-4.2	-3.9	-2.9	-2.8	-2.7	-2.4	-4.0	-3.8	-3.8	-3.7	-3.7
M-LP	-6.8	-6.8	-6.8	-7.6	-5.2	-5.4	-7.4	-6.9	-7.0	-9.0	-6.6	-6.9
H-AI	-2.2	-3.8	-4.0	-2.5	-3.4	-3.5	-2.3	-4.0	-4.2	-2.6	-3.8	-4.2
H-RA	-2.7	-4.5	-4.5	-3.3	-3.3	-3.2	-3.7	-5.3	-4.9	-4.6	-4.5	-4.6
H-LB	-2.4	-7.0	-5.8	-3.1	-4.4	-3.8	-3.3	-7.2	-6.2	-4.3	-6.3	-5.8
H-LP	-8.3	-11.7	-11.2	-9.1	-8.8	-8.7	-9.6	-12.2	-12.0	-10.7	-11.3	-11.2
Avg.	-3.6	-5.5	-5.2	-4.3	-4.2	-4.0	-4.2	-5.8	-5.6	-5.2	-5.4	-5.3

Encoding Latency = 1 LCU

Encoding Latency = 1 Picture

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Comparison between HM6-ALF and New HM7-ALF, CTC Sequences

- The new HM7-ALF achieves slightly better coding efficiency and significant complexity reduction

CTC	HM-6.0 LCU OPT			HM-7.0 NEW LL			HM-6.0 PIC OPT			HM-7.0 NEW HE		
BD-rate	Y(%)	Cb(%)	Cr(%)	Y(%)	Cb(%)	Cr(%)	Y(%)	Cb(%)	Cr(%)	Y(%)	Cb(%)	Cr(%)
M-AI	-1.1	-0.0	-0.0	-1.6	-2.7	-2.9	-1.7	-2.3	-2.5	-1.6	-3.1	-3.3
M-RA	-2.0	-0.5	-0.5	-2.7	-1.9	-1.7	-3.2	-1.3	-1.3	-3.1	-2.5	-2.3
M-LB	-1.6	-0.6	-0.4	-1.9	-2.3	-2.2	-2.3	-1.8	-1.7	-2.3	-3.0	-3.1
M-LP	-2.7	-1.4	-1.3	-3.2	-3.3	-3.0	-3.2	-2.3	-2.0	-3.6	-4.1	-4.0
H-AI	-1.2	-0.5	-0.5	-1.7	-3.7	-4.2	-1.9	-3.5	-3.7	-1.8	-4.2	-4.6
H-RA	-2.2	-0.9	-1.1	-2.8	-3.0	-3.1	-3.4	-2.8	-2.8	-3.3	-4.0	-4.1
H-LB	-1.6	-0.8	-0.8	-2.2	-3.3	-3.2	-2.5	-3.3	-2.8	-2.6	-4.6	-4.5
H-LP	-3.1	-1.4	-1.3	-3.9	-4.6	-4.4	-3.7	-3.7	-3.4	-4.5	-6.2	-6.2
Avg.	-1.9	-0.8	-0.7	-2.5	-3.1	-3.1	-2.7	-2.6	-2.5	-2.9	-4.0	-4.0

Encoding Latency = 1 LCU

Encoding Latency = 1 Picture

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Conclusion

- Non-normative encoder-only improvements
  - More accurate rate estimation in RDO process
  - Try up to eight previous APS

- Bug-fix of ticket #574
  - Swap coef[2] and coef[4] in the bitstream in software
  - No impact on coding efficiecny

- Overall results
  - BD-rate= -2.9% (Y), -4.0% (Cb), -4.0% (Cr) for CTC sequences
  - BD-rate= -5.2% (Y), -5.4% (Cb), -5.3% (Cr) for KTA sequences

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Thank you