

JCTVC-C082: TE10 Subtest 2:
Reduction of number of encoding passes
for quadtree-based adaptive loop filter (QALF)

TOSHIBA

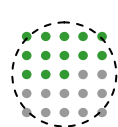
Summary

- **Specification and encoding method of Quadtree-Based Adaptive Loop Filter (QALF_{original})**
- **Introduction of encoding technique (2-pass QALF)**
- **Experimental results**
 - 0.1% coding efficiency loss from QALF_{original} or 0.5% coding efficiency loss from the anchor (QC_ALF)
 - Verified by MediaTek and MERCE
 - 14 test points out of 124 were slightly different
 - One potential reason of this mismatch is that Toshiba uses Windows OS and MediaTek and MERL use Linux OS
- **Discussion**
- **Conclusion**

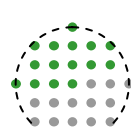
Specification and encoding method of QALF_{original}

- **A Wiener-based in-loop filter**

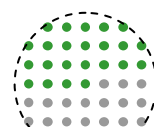
- One of the following filter shape (including offset) may be used



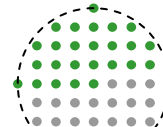
3: 5x5



2: 7x7(1)



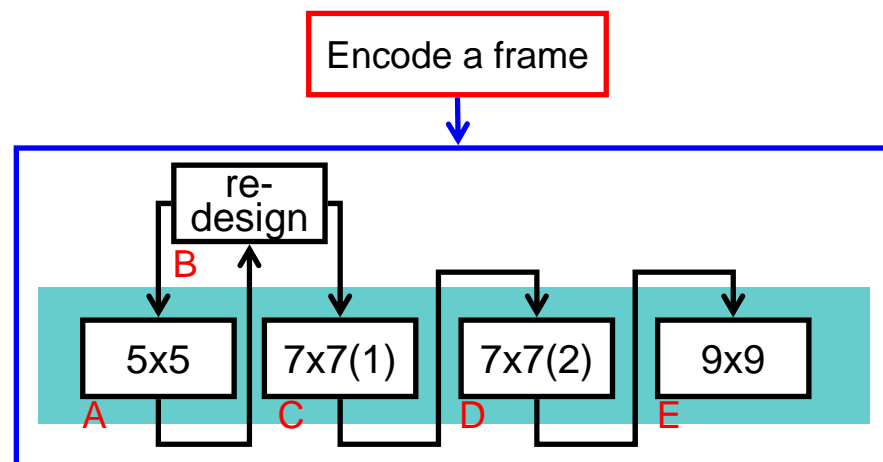
1: 7x7(2)



0: 9x9

- Encoder may select one of the above filter shapes according to RD criteria slice by slice
- Encoding logic (similar to the anchor (QC_ALF))

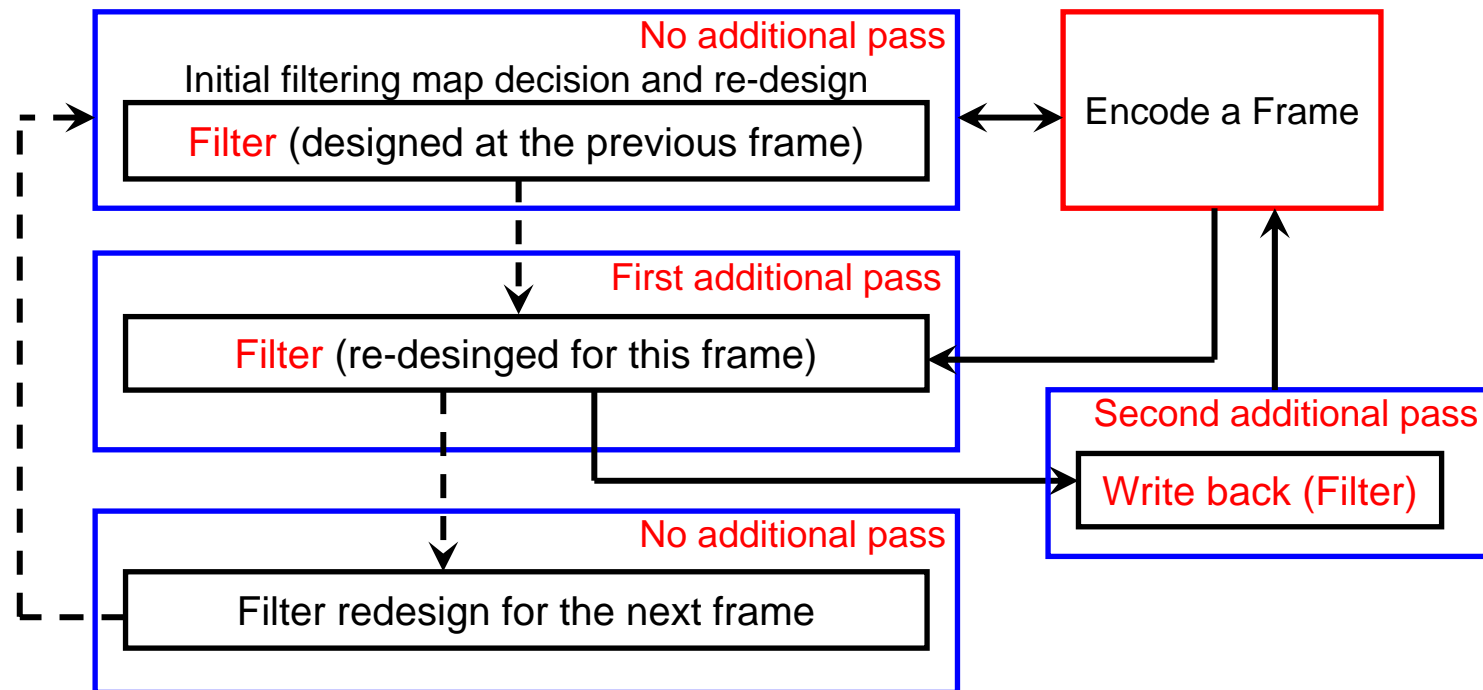
- A) 1 pass for initial filter design and apply by a 5x5 tap filter.
- B) 12 passes for the 5x5 tap filter redesign, filtering and CU depth decision. (i.e. 4 (CU_depth candidate) x 3(redesign) = 12)
- C) 1 pass for redesign of the 5x5 tap filter and filtering, and design for 7x7 tap filter
- D) 1 pass for 7x7 tap filtering, and design for 9x9 tap filter, and comparison with 5x5 tap results
- E) 1 pass for 9x9 tap filtering, and comparison with the best one among 5x5 and 7x7 tap results



Multiple times of frame memory access → Need reduction

Introduction of encoding technique (2-pass QALF)

- An encoding technique is introduced to reduce the number of frame memory access



Experimental results

- **Conditions**

- JCTVC-B300 and JCTVC-B310_r3 (TMuC 0.7.1, identical results with 0.7)
- High Efficiency, Random Access and Low Delay cases
- Anchor (reference): QC_ALF

Test Case	Random Access		Low Delay	
Class A	QALF	Proposed	QALF	Proposed
Class A	0.7	0.7	N/A	N/A
Class B	0.9	1.2	0.6	0.6
Class C	0.2	0.5	0.4	0.4
Class D	-0.4	-0.3	-0.2	-0.2
Class E	N/A	N/A	0.9	1.1
Total	0.4	0.5	0.4	0.5
Encoding time (%)	0.1% loss		0.1% loss	
Decoding time (%)		100		100
		99		98

Number of encoding passes: 16 (anchor), 2 (proposal)

Discussion (Related to JCTVC-C085)

- **Best performing in-loop filtering**
vs Best performing post-processing filtering
 - In-loop filtering
 - There is a contribution JCTVC-C214 to improve the coding efficiency of in-loop filtering
 - C214 : +0.8% → **6.0%** from no Wiener-based in-loop filtering for High Efficiency Low Delay case (cf. QC_ALF gives 5.2% gain)
 - Post-processing filtering
 - There is a contribution JCTVC-C113
 - 3.9%
 - 2.1% of additional coding efficiency by In-loop filtering

Discussion 2 (Related to JCTVC-C086)

- **Toshiba has been reporting the synergy effect (or interaction) between interpolation filter and in-loop filter**
 - JCTVC-A117: Video coding technology proposal by Toshiba
 - JCTVC-B043: Synergistic effect of high accuracy interpolation filter (HAIF) and quad-tree based adaptive loop filter (QALF) --- JMCKTA
 - Interpolation filter for creation of fractional pixels
 - In-loop filter for denoising integer pixels
 - JCTVC-C086: Experimental results of ALF on low complexity (TE12)
 - Low Complexity anchor does not include QC_ALF
 - Low Complexity anchor uses DIF-6tap
 - Test: QC_ALF on, DCTIF-6tap, QC_ALF on + DCTIF-6tap

Discussion 2 (cont'd)

Low Complexity, Random Access

	ALF	DCT-IF 6-tap	ALF + DCT-IF 6-tap
Class A	-3.92	0.53	-4.85
Class B	-4.67	-0.69	-5.96
Class C	-4.39	-2.94	-7.08
Class D	-5.93	-6.85	-11.41
All	-4.83	-2.77	-7.56

Low Complexity, Low Delay

	ALF	DCT-IF 6-tap	ALF + DCT-IF 6-tap
Class B	-4.40	1.09	-5.79
Class C	-4.89	-1.52	-7.95
Class D	-4.50	-5.14	-10.89
Class E	-2.90	3.50	-3.17
All	-4.27	-0.67	-7.11

Conclusion

- **2-pass QALF is introduced**
- **Loss of coding efficiency is 0.1% compared to multiple-pass**
- **This encoding technique can be applicable to the methods that adopt block-based filtering control**
- **This is good evidence of the possibility of reducing the number of encoder passes**

- **JCTVC-C085 reports the relative decoding time comparison between in-loop and post-processing filtering. In-loop filtering requires less decoding time while the coding efficiency is better. This means in-loop filtering is more efficient scheme in terms of coding efficiency as well as power consumption of decoder.**
- **JCTVC-C086 and previous Toshiba's contributions report interaction with interpolation filter.**

Conclusion (cont'd)

- There are potential requests from content holder to guarantee bit-wise results by codec. It would be better to consider HEVC to satisfy these potential requests, since content holders' opinion is important for many industries.
(Same opinion was presented in the presentation of JCTVC-C091)
- Approximately **75% of CfP submissions** (including best performing submission) introduced adaptive loop filtering.
- There is a contribution JCTVC-C121 (signed by **6 companies**) which suggests an approach toward definition of Test Model. Inclusion of in-loop filtering is suggested for High Efficiency coding.
- These are good evidence that many companies/parties think **adaptive in-loop filtering should be included** in the specification.