



REDEFINING MOBILITY



JCTVC-B095

Encoder complexity analysis and performance report on adaptive loop filter

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Motivations

- Encoder issues
 - Multiple passes to obtain filter coefficients & filtered/not filtered map
 - High HW complexity
 - On-chip memory (OCMEM) size increase or
 - Memory bandwidth and power increase
- Analyze complexity vs. performance of different adaptive in-loop filter (ALF) algorithm
- Performance report according to ALF method categories
 - Separate quad tree (QT) vs. coding unit (CU) synchronized
 - Filter shapes and types

Complexity of different ALF

- In current TMuC software implementation,
- Non-separable (diamond/rectangular) ALF
 - 18 passes
 - 1 pass: initial filter decision
 - 15 passes: CU adaptive filter decision
 - 2 passes: filter tap decision
- Separable ALF
 - 34 passes
 - 4 passes: filter tap decision
 - 30 passes: CU adaptive filter decision

Complexity issues in HW implementation

- 2 set of frame buffers needed
 - Input
 - Reconstructed

- Using full size OCMEM
 - Significant additional OCMEM needed
 - Conventional size of OCMEM is ~512KB

- Partial OCMEM and read/write to DDR (in DPB)
 - Memory BW increase
 - Power consumption increase
 - Power consumption of DDR >> OCMEM

Alternatives

- Non-separable diamond simplified ALF (2 passes)
 - Encoding pass. Deriving filter coefficients after the end of the encoding pass.
 - Filtering Pass. Apply the filter & CU level filtering decision
 - w/o redesigning the filters
- Post filter (only encoding pass), T09-SG16-C-0128

Results IPPP

	ALF off	Diamond	Diamond 2-pass 9x9 tap	Post Filter
WQVGA	RaceHorses	-3.42	-3.29	-3.08
	BasketballPass	-2.87	-2.16	-1.96
	BlowingBubbles	-1.9	-1.55	-0.93
	BQSquare	-4.68	-4.32	-3.67
	WQVGA_AVG	-3.22	-2.83	-2.41
WVGA	RaceHorses	-4.56	-4.37	-3.88
	BasketballDrill	-9.72	-6.89	-4.34
	PartyScene	-2.67	-2.2	-2.42
	BQMall	-4.2	-3.14	-3.07
	WVGA_AVG	-5.29	-4.15	-3.43
720p	Vidyo1	-4.39	-1.3	-3.78
	Vidyo3	-11.27	-4.69	-3.65
	Vidyo4	-5.86	-2.26	-4.82
	720p_AVG	-7.17	-2.75	-4.08
1080p	ParkScene	-2.92	-3.18	-2.89
	Kimono	-5.17	-4.85	-4.48
	BasketballDrive	-5.70	-4.90	-3.44
	Cactus	-3.21	-1.33	-3.7
	BQTerrace	-9.46	-8.22	-4.94
	1080p_AVG	-5.29	-4.49	-3.89
	AVG	-5.13	-3.67	-3.44

Results, HierB

	ALF off	Diamond	Diamond 2-pass 9x9 tap	Post Filter
WQVGA	RaceHorses	-2.85	-2.89	-3.83
	BasketballPass	-1.43	-1.23	-2.18
	BlowingBubbles	-1.3	-0.95	-1.07
	BQSquare	-4.49	-4.2	-3.98
	WQVGA_AVG	-2.52	-2.32	-2.77
WVGA	RaceHorses	-4.72	-4.7	-4.75
	BasketballDrill	-4.62	-3.23	-2.8
	PartyScene	-2.37	-2.09	-2.04
	BQMall	-3.16	-2.85	-2.85
	WVGA_AVG	-3.72	-3.22	-3.11
720p	Vidyo1	-3.96	-2.28	-4.08
	Vidyo3	-8.59	-4.52	-6.19
	Vidyo4	-4.92	-3.12	-4.9
	720p_AVG	-5.82	-3.31	-5.06
1080p	ParkScene	-3.41	-3.34	-3.09
	Kimono	-4.53	-4.48	-4.18
	BasketballDrive	-5.71	-5.65	-5.1
	Cactus	-4.59	-3.66	-5.15
	BQTerrace	-13.68	-13.21	-9.52
	1080p_AVG	-6.38	-6.07	-5.41
	AVG	-4.65	-3.9	-4.11

Performance report on different ALF methods in TMuC

- Separate Quadtree vs. CU synchronized

- Complexity of separate QT > CU synchronized

- Additional processing for determining of QT structures

- Pruning/merging quad tree based on RD cost

0	0	0	0
1	0	1	0
1	0	0	
1	1		

Separate Quadtree

0	0	0
	1	0
1	0	

CU Synchronized

- Filter shapes and types

- 7x7 separable filters

- 7-tap symmetric filter: 4 multiplications/pixel for each (vertical/horizontal) direction
 - Total of 8 multiplications/pixel

- 5x5 diamond shaped filters (point symmetric)

- Total of 7 multiplications/pixel

Results- QT vs. CU & filter shape, IPPP

	ALF off	Separable QT	Separable CU	Diamond 5x5 tap CU	Separable 7 tap CU
WQVGA	RaceHorses	-3.05	-3.29	-1.87	-1.62
	BasketballPass	-1.35	-1.41	-2.29	-0.96
	BlowingBubbles	-1.80	-1.80	-1.32	-1.11
	BQSquare	-4.58	-4.69	-2.79	-2.68
	WQVGA_AVG	-2.69	-2.79	-2.07	-1.59
WVGA	RaceHorses	-3.75	-3.66	-2.67	-2.25
	BasketballDrill	-6.29	-6.21	-6.34	-5.07
	PartyScene	-2.26	-2.23	-1.93	-1.71
	BQMall	-3.43	-3.54	-3.2	-2.43
	WVGA_AVG	-3.93	-3.91	-3.54	-2.87
720p	Vidyo1	-3.28	-3.43	-3.1	-2.26
	Vidyo3	-8.91	-9.17	-7.63	-6.15
	Vidyo4	-4.71	-4.59	-4.71	-3.56
	720p_AVG	-5.63	-5.73	-5.15	-3.99
1080p	ParkScene	-3.51	-3.51	-2.00	-1.5
	Kimono	-4.52	-4.51	-3.67	-3.54
	BasketballDrive	-3.12	-3.07	-4.01	-2.01
	Cactus	-2.92	-2.82	-2.46	-1.68
	BQTerrace	-5.99	-5.9	-5.01	-2.69
	1080p_AVG	-4.01	-3.96	-3.43	-2.28
	AVG	-3.97	-3.99	-3.44	-2.58

Results- QT vs. CU & filter shape, HierB

	ALF off	Separable QT	Separable CU	Diamond 5x5 tap CU	Separable 7 tap CU
WQVGA	RaceHorses	-2.72	-2.72	-1.7	-1.98
	BasketballPass	-0.75	-0.75	-0.97	-0.55
	BlowingBubbles	-1.03	-1.2	-0.92	-0.93
	BQSquare	-3.92	-4.09	-3.53	-3.25
	WQVGA_AVG	-2.11	-2.19	-1.78	-1.67
WVGA	RaceHorses	-3.6	-3.47	-2.76	-2.69
	BasketballDrill	-2.21	-2.24	-2.66	-1.72
	PartyScene	-1.89	-1.9	-1.84	-1.59
	BQMall	-2.03	-2.15	-2.59	-1.52
	WVGA_AVG	-2.43	-2.44	-2.46	-1.88
720p	Vidyo1	-2.46	-2.47	-2.65	-1.73
	Vidyo3	-6.52	-6.42	-6.66	-4.34
	Vidyo4	-3.57	-3.28	-3.88	-2.41
	720p_AVG	-4.18	-4.07	-4.40	-2.83
1080p	ParkScene	-2.91	-2.87	-2.51	-2.07
	Kimono	-3.83	-3.81	-3.05	-3.02
	BasketballDrive	-3.13	-2.99	-3.91	-2.13
	Cactus	-3.25	-3.21	-3.25	-2.29
	BQTerrace	-6.69	-6.48	-8.62	-4.24
	1080p_AVG	-3.96	-3.87	-4.27	-2.75
	AVG	-3.16	-3.13	-3.22	-2.28

Conclusion

- Trade off between complexity and performance of different ALF
- We suggest to include post filter in Loop Filtering Ad-Hoc Group discussions.