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JCTVC-B043

## Synergistic Effect of High Accuracy Interpolation Filter (HAIF) and Quad-tree based Adaptive Loop Filter (QALF)

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# Summary

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- **Filter based techniques**
  - HAIF (High Accuracy Interpolation Filter)
  - QALF (Quad-tree based Adaptive Loop Filter)
- **Synergistic effect of HAIF and QALF**
- **Experimental results**
  - HAIF
    - CS 1: average of 1.89%, up to 13.25%
    - CS 2: average of **-0.13%**, up to 16.96%
  - QALF
    - CS 1: average of 5.12%, up to 12.17%
    - CS 2: average of 7.11%, up to 15.29%
  - HAIF+QALF
    - CS 1: average of 6.53%, up to 20.21%
    - CS 2: average of 9.23%, up to 19.10%

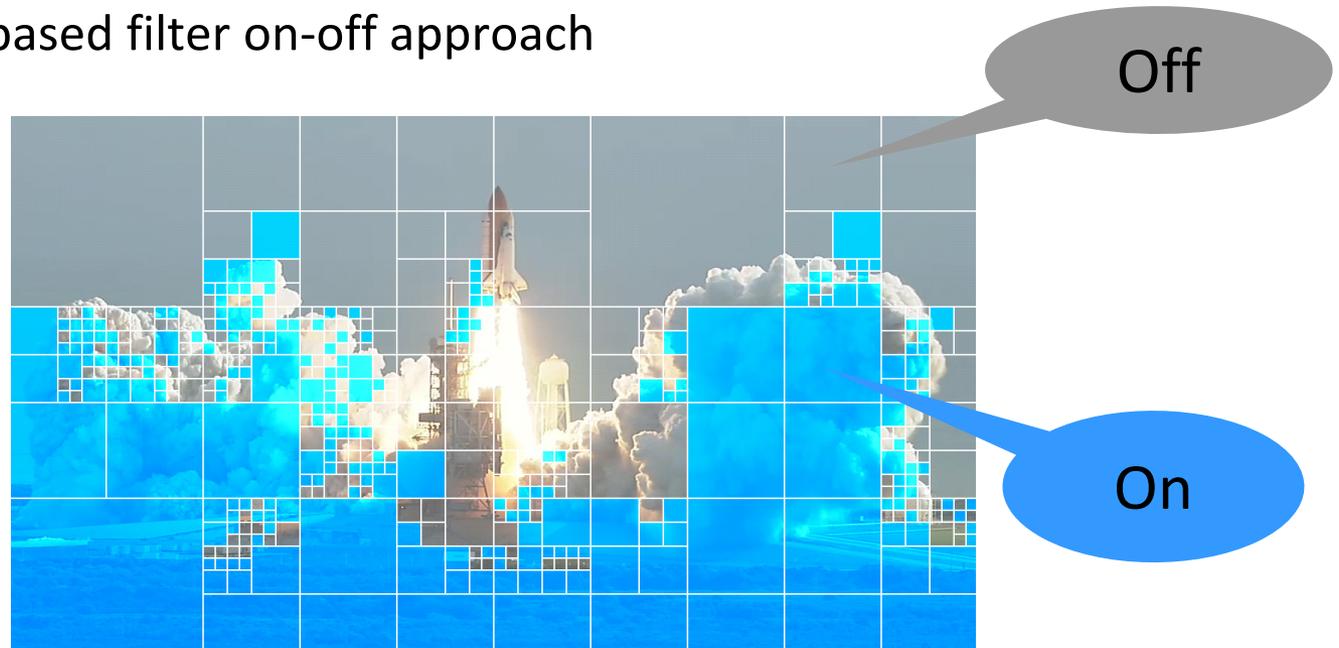
# High Accuracy Interpolation Filter (HAIF)

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- **High Accuracy Interpolation Filter (JCTVC-A117)**
  - 8-tap filter for  $\frac{1}{4}$ -pel resolution
    - 1/4 pixel position:  $\{-3, 12, -37, 229, 71, -21, 6, -1\} // 256$
    - 1/2 pixel position:  $\{-3, 12, -39, 158, 158, -39, 12, -3\} // 256$
  - 1 D FIR filter
  - Calculate fractional-pel directly from integer-pel

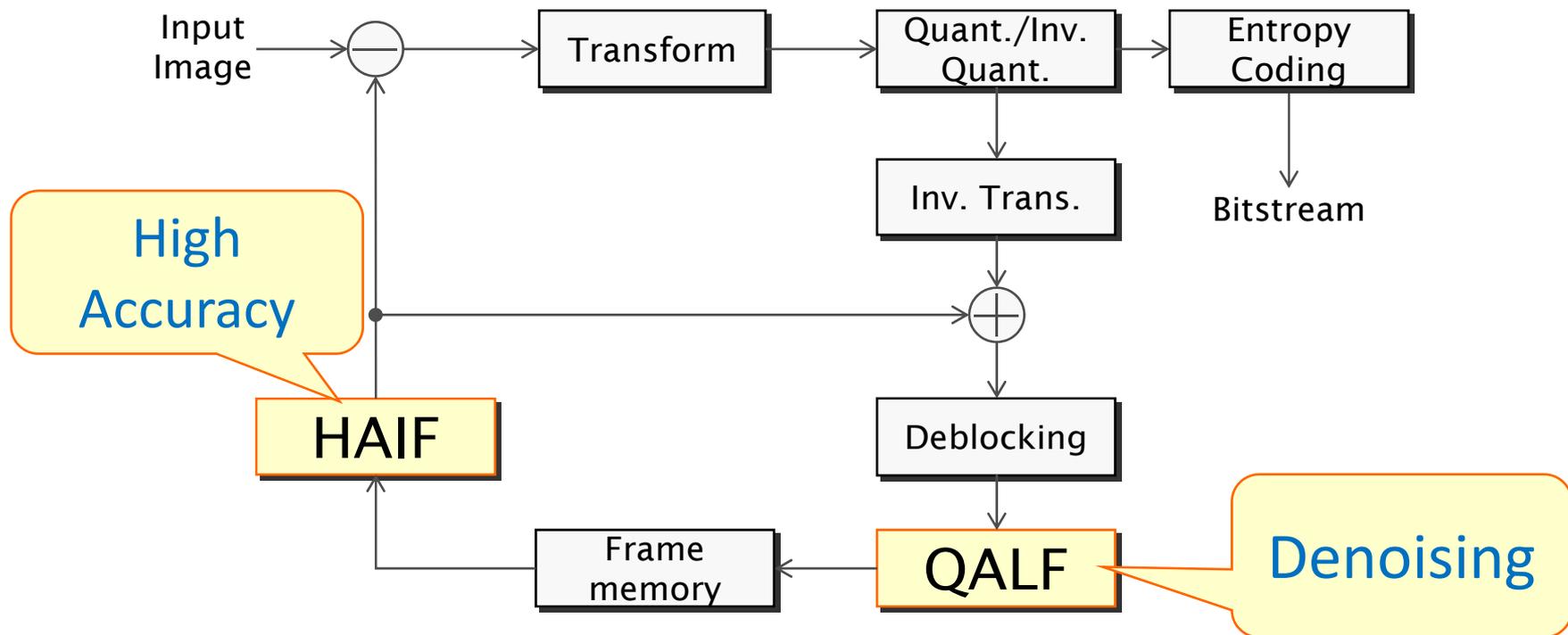
# Quad-tree based Adaptive Loop Filter (QALF)

- **Quad-tree based Adaptive Loop Filter (same as JM11.0KTA2.6r1)**
  - Loop filter based on Wiener filter
  - Quad-tree based filter on-off approach



- Point symmetry FIR filter with offset
- Filter tap size is 5x5, 7x7 or 9x9 tap slice by slice

# Combination of QALF and HAIF



- The purposes of interpolation filter;
  - A) To reduce coding noise of decoded image
  - B) To adjust the pixel position to fractional pixel position→ HAIF is concentrated to B).  
→ Each fractional pixel position is derived directly from pixels at integer pixel positions to minimize low pass filter characteristics.

# Experimental Conditions

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- JM11.0KTA2.6r1 (HAIF is additionally implemented into SW)
- Test conditions are based on VCEG-AJ10r1.
- QP values are QPI=(26, 30, 34, 38); QPP=QPI+1; QPB=QPI+2.
- All CfP test sequences, the # of frames is about 2 seconds.

Class	Sequence	StartFrame	# of Coding Frames	
			Hierarchical B (CS1)	IPPP (CS2)
A	Traffic	0	65	N/A
	People on Street	0	65	N/A
B1	Kimono	116	49	49
	ParkScene	0	49	49
B2	Cactus	0	97	97
	BasketballDrive	0	97	97
	BQTerrace	0	129	129
C	BasketballDrill	0	97	97
	BQMall	0	129	129
	PartyScene	0	97	97
	RaceHorses	0	65	65
D	BasketballPass	0	97	97
	BQSquare	0	129	129
	BlowingBubbles	0	97	97
	RaceHorses	0	65	65
E	Vidyo1	0	N/A	129
	Vidyo3	0	N/A	129
	Vidyo4	0	N/A	129

# Experimental results of CS1 and CS2

Categories	Sequences	Hierarchical B structure (CS1)			IPPP structure (CS2)		
		HAIF	QALF	HAIF+QALF	HAIF	QALF	HAIF+QALF
		$\Delta$ Bitrate (%)	$\Delta$ Bitrate (%)	$\Delta$ Bitrate (%)	$\Delta$ Bitrate (%)	$\Delta$ Bitrate (%)	$\Delta$ Bitrate (%)
Class A	PeopleOnStreet	-0.95	7.22	7.37	N/A		
	Traffic	0.79	5.46	5.95			
Class B	BQTerrace	2.22	11.12	13.67	-8.70	15.29	19.10
	BasketballDrive	0.62	4.01	4.51	0.01	8.69	9.58
	Cactus	0.45	3.96	4.52	-1.64	5.68	6.75
	Kimono1	1.15	6.86	7.05	0.42	8.46	8.75
	ParkScene	1.27	3.60	4.31	-0.34	3.67	5.86
Class C	BQMall	0.98	3.02	3.97	-0.70	5.83	7.12
	BasketballDrill	1.40	5.80	6.73	0.93	12.14	12.78
	PartyScene	5.55	6.48	9.51	7.31	5.34	10.24
	RaceHorses	-0.32	2.23	3.12	-1.90	2.67	3.43
Class D	BQSquare	13.25	12.17	20.21	16.96	7.48	19.84
	BasketballPass	0.29	1.72	2.16	-2.16	4.76	5.02
	BlowingBubbles	2.12	1.59	2.99	2.53	2.35	5.05
	RaceHorses	-0.50	1.52	1.93	-1.38	1.95	2.26
Class E	vidyo1	N/A			-3.51	7.71	8.84
	vidyo3				-5.09	12.81	13.93
	vidyo4				-4.78	8.93	9.15
Class A Average		-0.08	6.34	6.66	N/A		
Class B Average		1.14	5.91	6.81	-2.05	8.36	10.01
Class C Average		1.90	4.38	5.83	1.41	6.49	8.39
Class D Average		3.79	4.25	6.82	3.99	4.13	8.04
Class E Average		N/A			-4.46	9.82	10.64
<b>Total Average</b>		<b>1.89</b>	<b>5.12</b>	<b>6.53</b>	<b>-0.13</b>	<b>7.11</b>	<b>9.23</b>

# Conclusion

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- **Experimental results of HAIF, QALF, and these combination are reported**
  - Coding gain of HAIF itself is not so high, however the combination of HAIF and QALF has always additional gain.
  - By combining HAIF and QALF, the synergistic effect is observed for IPPP case.
- **Suggestion**
  - Since the interpolation filter and the in-loop filter have strong relation as a filter processing technology, it is suggested to discuss not only about the coding gain assessment of interpolation filter itself but also about the assessment of the combination of both interpolation filter and in-loop filter.

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