JCTVC-A028

Adaptive Frequency Weighting Quantization

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Outline

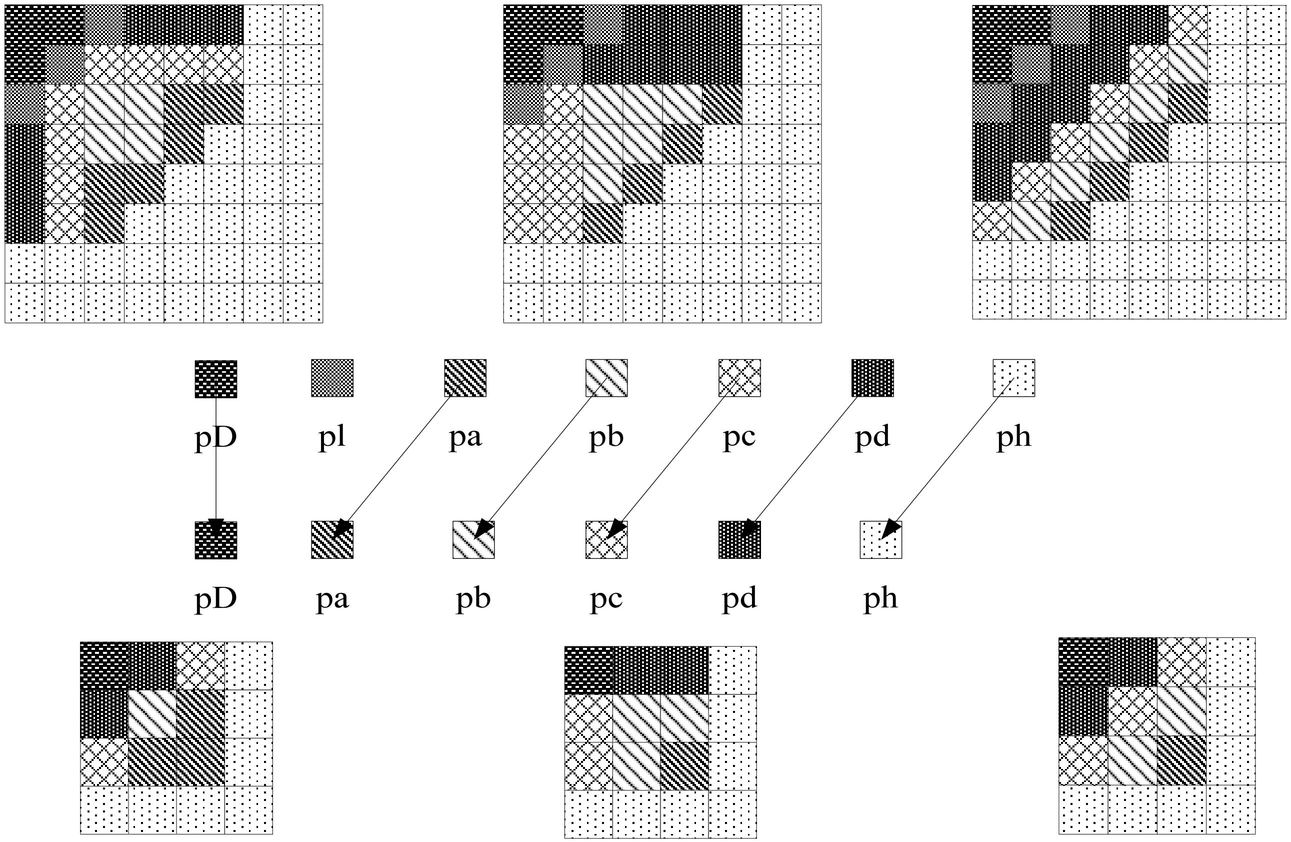
- Motivation
- Parameterized frequency weighting
- Adaptive quantization mode selection
- Experimental Results
- Complexity analysis
- Conclusions

Motivation

- **This proposal considers a macroblock level quantization tool for the following reasons**
- **1) Quantization matrices loaded in picture level results in bits overhead and hard to be used in small picture size.**
- **2) Quantization weighting matrices are flexible but hard for end-user to control the coding picture quality via each value in the quantization weighting matrices.**
- **3) Non-uniform quantization is not available for macroblock level for considering the picture content such as textures, details and undetails.**

This proposal using parameterized frequency weighting models in picture level and implement non–uniform quantization in macroblock level for considering the property of local textures. Fewer bits used in picture level and no extra bits needed in macroblock.

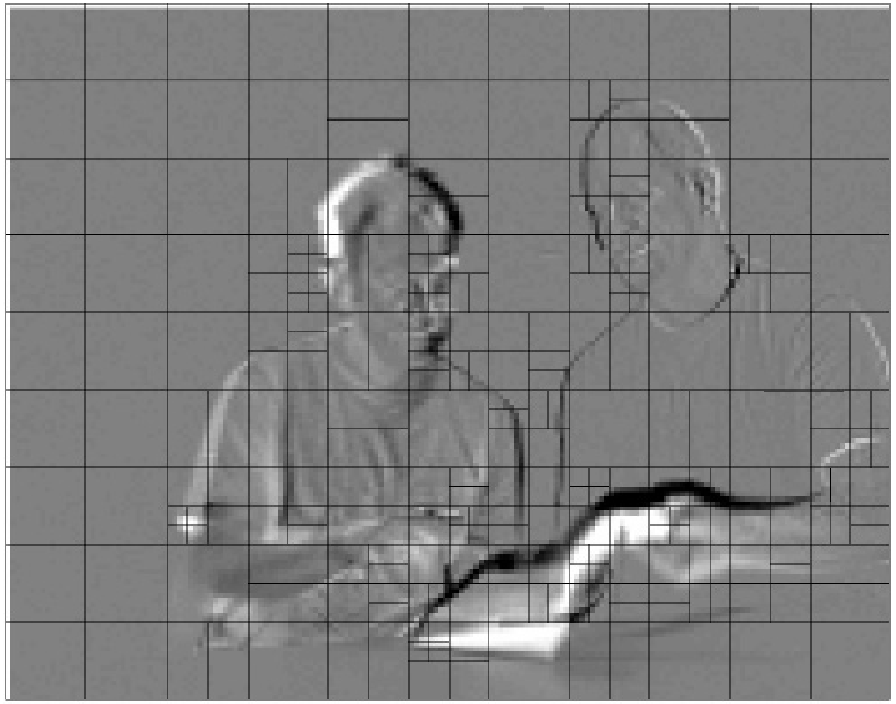
Parameterized frequency weighting

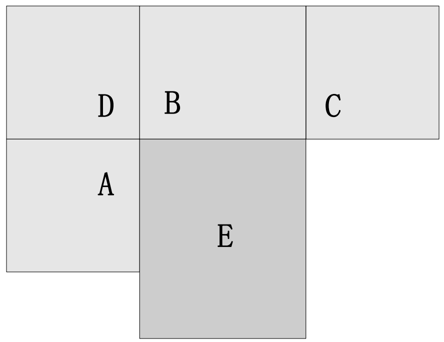


Frequency band weighting model

Adaptive quantization mode selection

(1) Quantization mode 0:
Default quantization mode, flat quantization
(2) Quantization mode 1:
Details-preserving mode, the quantized/dequantized block would preserve image texture details as more as enough.
(3) Quantization mode 2:
Undetailed quantization mode, the quantized/ dequantized block would not preserve texture details more.

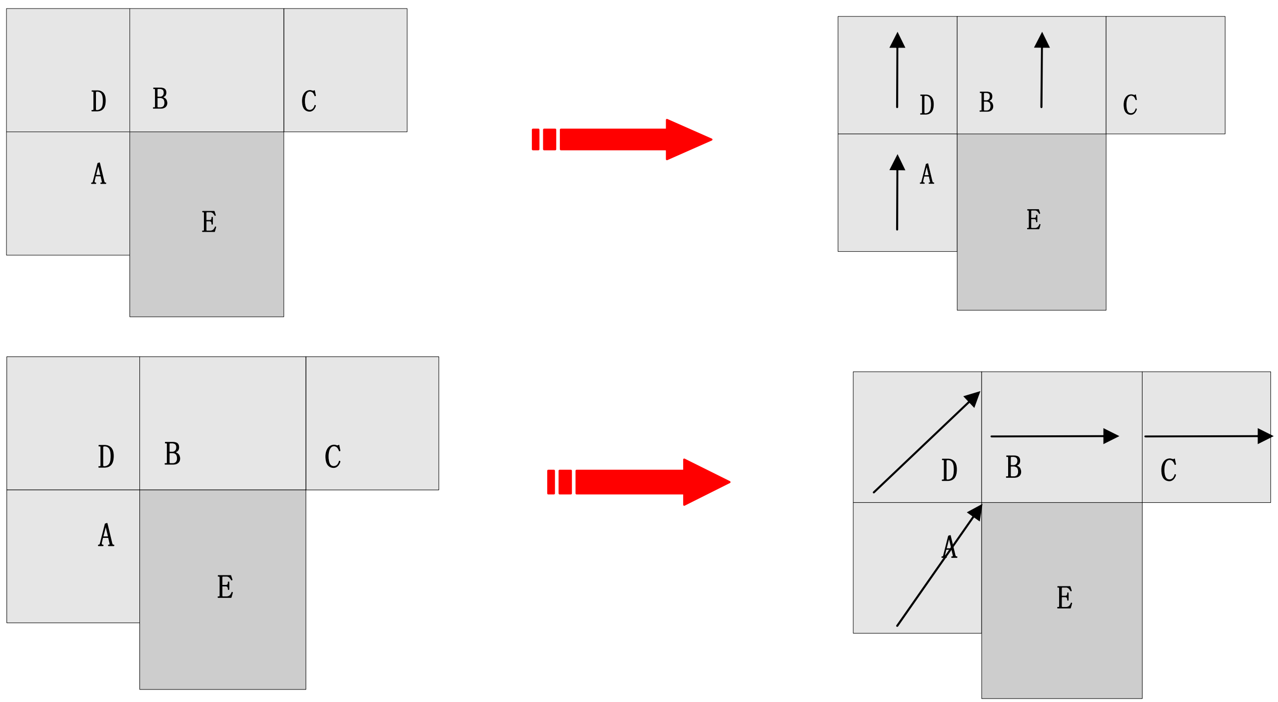




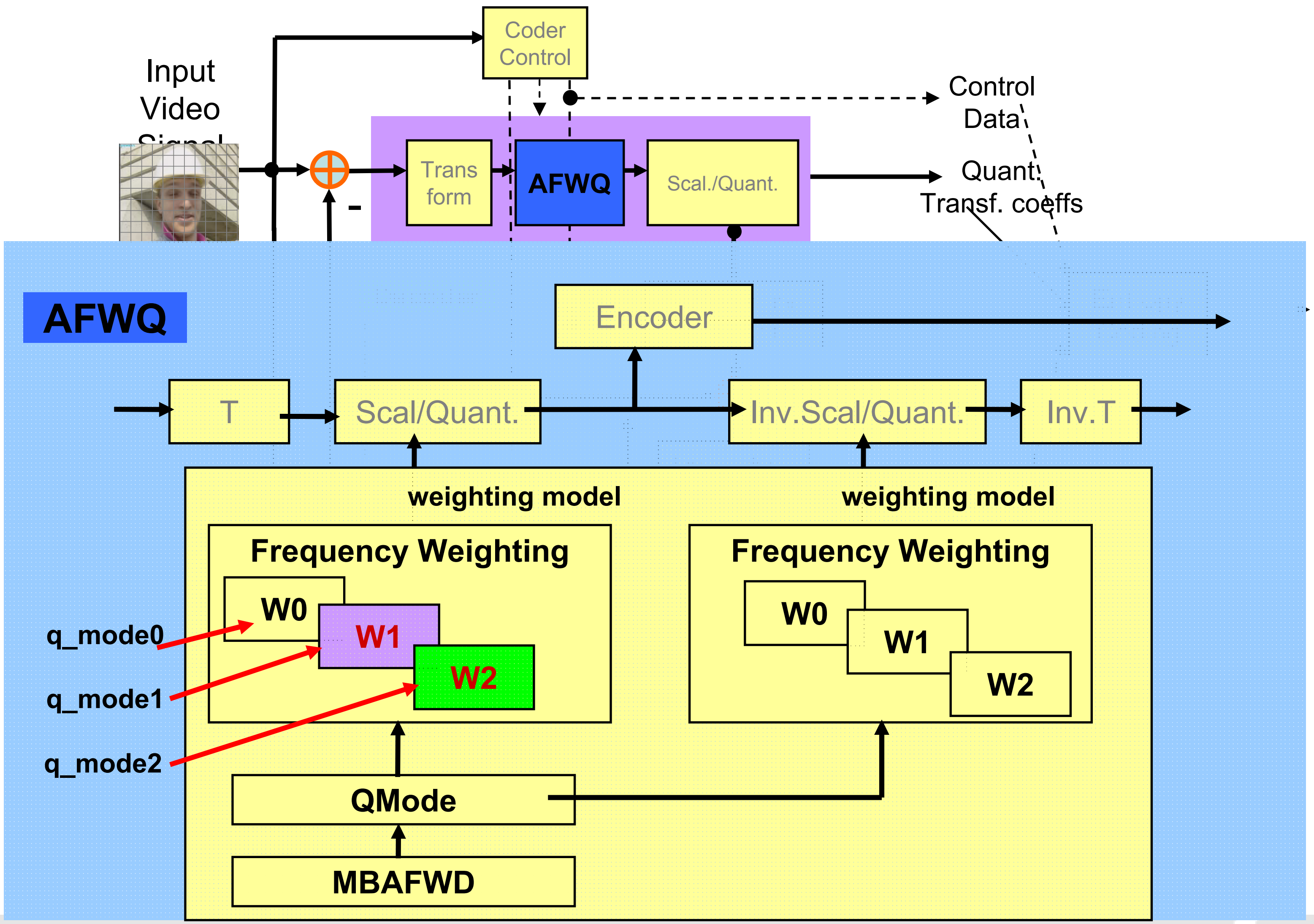
Adaptive quantization mode selection

intra-coding — Intra prediction mode(block size and intra-predict direction of neighbor blocks may be used in the quantization mode selection

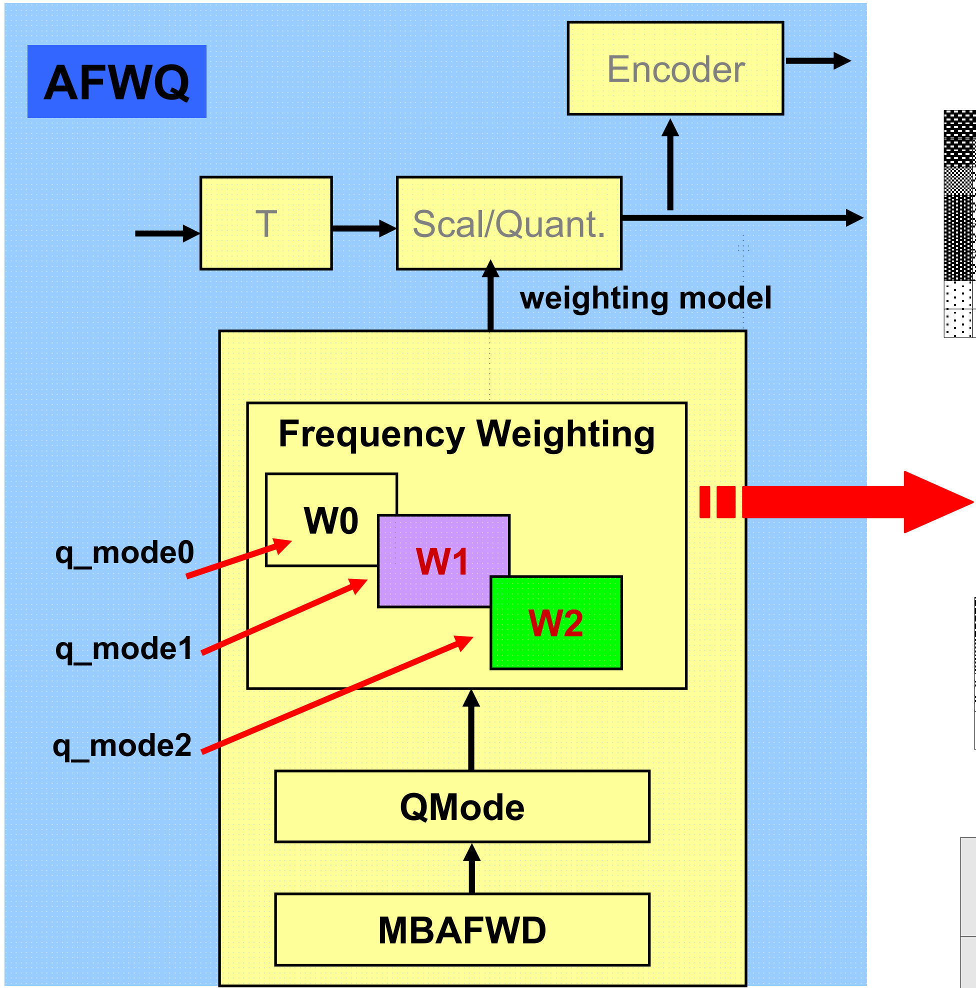
inter-coding — Inter prediction mode (block type and block size) of neighbor blocks may be used in the quantization mode selection



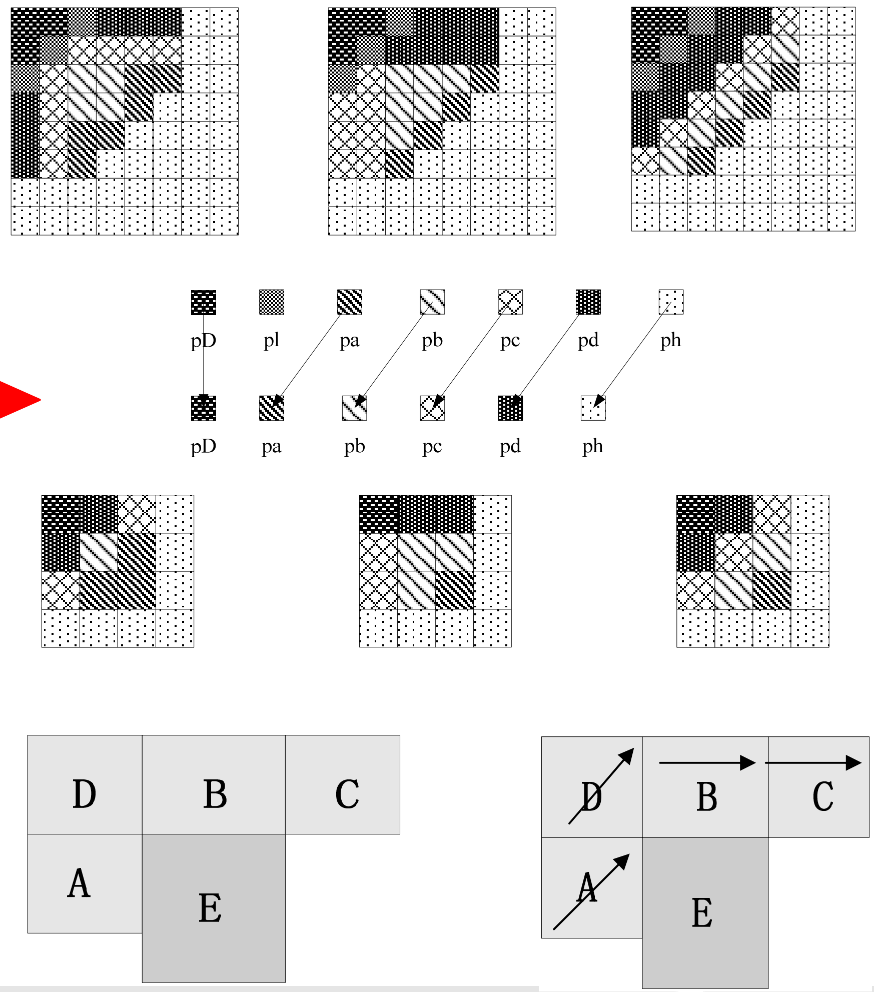
Adaptive Frequency Weighting Quantization (AFWQ)



Adaptive Frequency Weighting Quantization (AFWQ)



Frequency band weighting model



Syntax

slice_header( ) {	C	Descriptor
… … … …		
adaptive_frequency_weighting_flag	1	u(1)
if(adaptive_frequency_weighting_flag){		
mb_adaptive_weighting_quant_enable	1	u(1)
weighting quant model	2	u(2)
for(i=0; i<7; i++)		
weighting_quant_param_detailed		se(v)
for(i=0; i<7; i++)		
weighting_quant_param_undetailed		se(v)
}		
}		

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Experimental Results

- anchcor: JM11.0_KTA2.6 r1 AVC

-The QP points setting are fixed QPs as same as the configuration in the Alpha anchor and Beta anchor bitstreams.

-three quantization modes(0～2) are used

-Constraint 1 & constraint 2

-RDOQ QP_NUM=1

Experimental Results

alpha	High bitrate		Low bitrate	
	Bitrate Saving	PSNR Gain	Bitrate Saving	PSNR Gain
Class D_WQVGA				
BQSquare_416x240_60	1.97	-0.07	0.78	-0.03
BasketballPass_416x240_50	-1.68	0.08	-2.24	0.10
BlowingBubbles_416x240_50	-0.74	0.03	-2.68	0.10
RaceHorses_416x240_30	-0.86	0.04	-1.67	0.08
average	**-0.33**	**0.02**	**-1.45**	**0.06**
Class C_WVGA				
PartyScene_832x480_50	-3.90	0.15	-4.83	0.18
BQMall_832x480_60	-2.31	0.11	-2.61	0.14
BasketballDrill_832x480_50	-4.65	0.19	-5.18	0.23
RaceHorses_832x480_30	-1.71	0.07	-2.33	0.10
average	**-3.14**	**0.13**	**-3.74**	**0.16**
Class B_1080P				
Kimono1_1920x1080_24	-2.88	0.09	-3.35	0.13
Cactus_1920x1080_50	-3.32	0.09	-3.82	0.12
BasketballDrive_1920x1080_50	-2.14	0.06	-2.64	0.09
ParkScene_1920x1080_24	-3.31	0.12	-3.18	0.12
BQTerrace_1920x1080_60	-2.61	0.04	-2.90	0.06
ChristmasTree_1920x1080_50	-2.36	0.07	-3.00	0.10
Wisley2_1920x1080_50	-6.31	0.23	-6.19	0.24
average	**-3.28**	**0.10**	**-3.58**	**0.12**
Class A_2K				
Traffic_2560x1600_30	-4.77	0.17	-4.27	0.18
PeopleOnStreet_2560x1600_30	-1.18	0.06	-1.54	0.08
average	**-2.97**	**0.12**	**-2.90**	**0.13**
average(High rate/Low rate)	**-2.51**	**0.09**	**-3.04**	**0.12**

alpha (random access)

anchor: JM11.0_KTA2.6 r1 AVC

alpha	Bitrate Saving	PSNR Gain
High bitrate	**-2.51**	**0.09**
Low bitrate	**-3.04**	**0.12**
average(all)	**-2.78**	**0.11**

Experimental Results

alpha (random access)

alpha (random access)	High bitrate		Low bitrate	
	Bitrate Saving	PSNR Gain	Bitrate Saving	PSNR Gain
Class D_WQVGA	-0.33	0.02	-1.45	0.06
Class C_WVGA	-3.14	0.13	-3.74	0.16
Class B_1080P	-3.28	0.10	-3.58	0.12
Class A_2K	-2.97	0.12	-2.90	0.13
average(High rate/Low rate)	-2.51	0.09	-3.04	0.12

alpha	Bitrate Saving	PSNR Gain
High bitrate	-2.51	0.09
Low bitrate	-3.04	0.12
average(all)	-2.78	0.11

Experimental Results

Beta	High bitrate		Low bitrate	
	Bitrate Saving	PSNR Gain	Bitrate Saving	PSNR Gain
Class D_WQVGA				
BQSquare	0.41	-0.01	1.33	-0.04
BasketballPass	-3.79	0.18	-4.04	0.18
BlowingBubbles_416x240_50	-0.49	0.02	-1.14	0.04
RaceHorses_416x240_30	-1.21	0.06	-2.47	0.11
average	**-1.27**	**0.06**	**-1.58**	**0.07**
Class C_WVGA				
PartyScene	-2.01	0.07	-3.43	0.11
BQMall 2	-1.72	0.08	-1.84	0.09
BasketballDrill	-3.70	0.15	-4.33	0.18
RaceHorses	-3.33	0.13	-4.19	0.16
average	**-2.69**	**0.11**	**-3.45**	**0.14**
Class B_1080P				
Kimono	-1.39	0.05	-1.78	0.08
Cactus	-3.75	0.12	-3.83	0.13
BasketballDrive	-3.25	0.11	-3.47	0.14
Parkscene	-2.72	0.10	-3.02	0.11
BQTerrace_1920x1080_60	-2.06	0.05	-1.67	0.05
ChristmasTree_1920x1080_50	-2.37	0.08	-2.86	0.10
Wisley2_1920x1080_50	-7.41	0.24	-7.88	0.27
average	**-3.28**	**0.11**	**-3.50**	**0.13**
Class A_720P				
vidyo1_720p_60	-3.46	0.15	-2.42	0.12
vidyo3_720p_60	-1.11	0.05	-1.00	0.05
vidyo4_720p_60	-1.75	0.07	-1.52	0.07
average	**-2.11**	**0.09**	**-1.65**	**0.08**
average(High rate/Low rate)	**-2.51**	**0.09**	**-2.75**	**0.11**

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Beta (low delay)

anchor: JM11.0_KTA2.6 r1 AVC

Beta	Bitrate Saving	PSNR Gain
High bitrate	**-2.51**	**0.09**
Low bitrate	**-2.75**	**0.11**
average(all)	**-2.63**	**0.10**

Experimental Results

Beta (low delay)

Beta (low delay)	High bitrate		Low bitrate	
	Bitrate Saving	PSNR Gain	Bitrate Saving	PSNR Gain
Class D_WQVGA	-1.27	0.06	-1.58	0.07
Class C_WVGA	-2.69	0.11	-3.45	0.14
Class B_1080P	-3.28	0.11	-3.50	0.13
Class E_720P	-2.11	0.09	-1.65	0.08
average(High rate/Low rate)	-2.51	0.09	-2.75	0.11

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Beta	Bitrate Saving	PSNR Gain
High bitrate	-2.51	0.09
Low bitrate	-2.75	0.11
average(all)	-2.63	0.10

Complexity analysis

Table 1 Encoding time comparison

		EncodingTime(second) [1]			EncodingTime(times)		
	QP	JM	AFWQ	AQMS	AFWQ_vs_JM	AQMS_vs_JM	AQMS_vs_AFWQ
alpha	25	13890.899	13273.781	23041.899	0.956	1.659	1.736
	27	12997.832	12878.395	22536.822	0.991	1.734	1.750
	30	12991.921	12708.52	22159.925	0.978	1.706	1.744
	33	12600.891	12315.385	20889.486	0.977	1.658	1.696
	38	11835.699	11127.715	18743.736	0.940	1.584	1.684
beta	27	4791.643	4270.097	10635.058	0.891	2.220	2.491
	30	5034.199	4345.924	11390.935	0.863	2.263	2.621
	33	5606.589	5114.711	11959.278	0.912	2.133	2.338
	37	6474.76	5649.957	12634.541	0.873	1.951	2.236
	40	6577.924	6026.426	12640.646	0.916	1.922	2.098

[1] Xeon X5440 2.93GHz , 16GB RAM, Windows XP SP2（x64）, BasketballDrive_1920x1080_50

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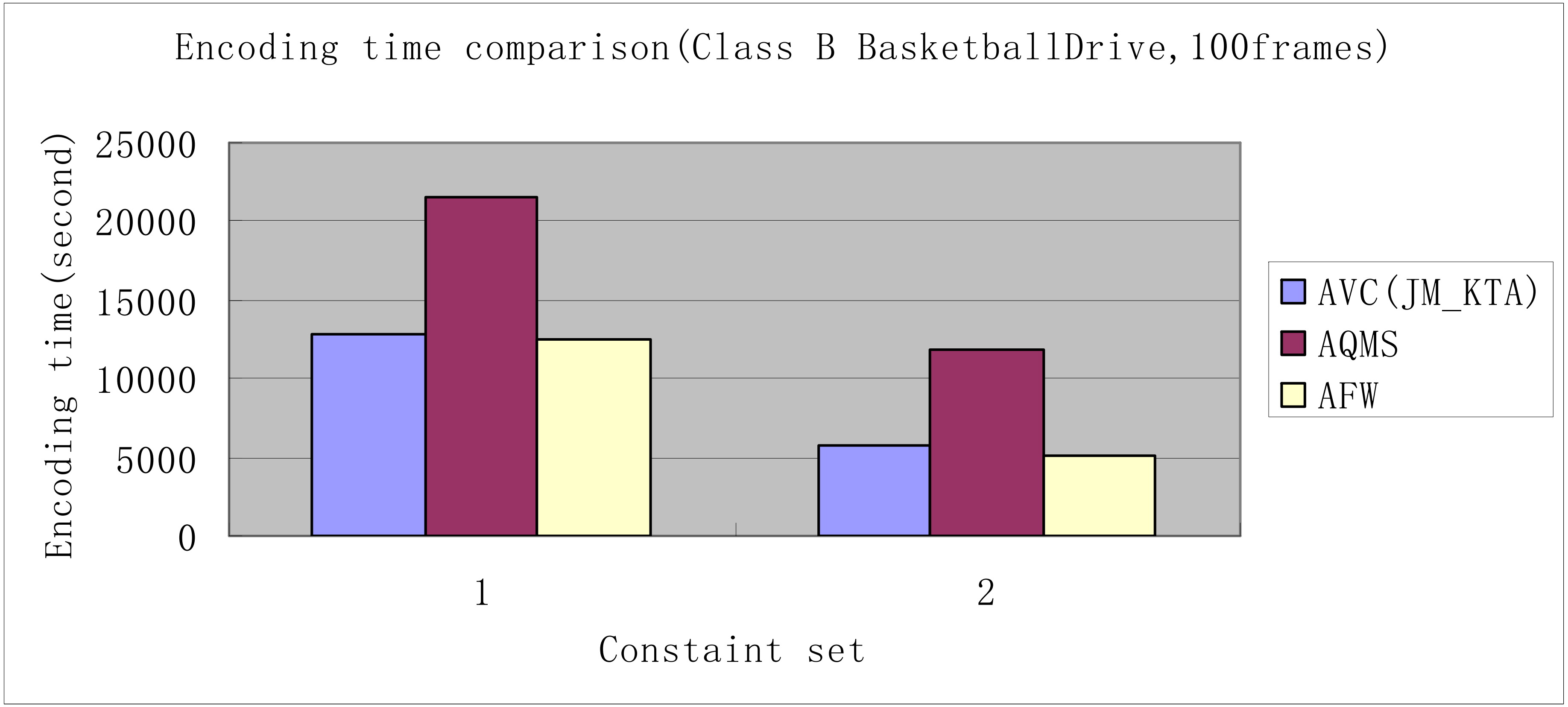
- the encoding time of AFWQ is observed no increasing comparing to the KTA JM anchor.

Complexity analysis



The encoding time of AFWQ is observed no increasing comparing to the KTA JM anchor.

Complexity analysis

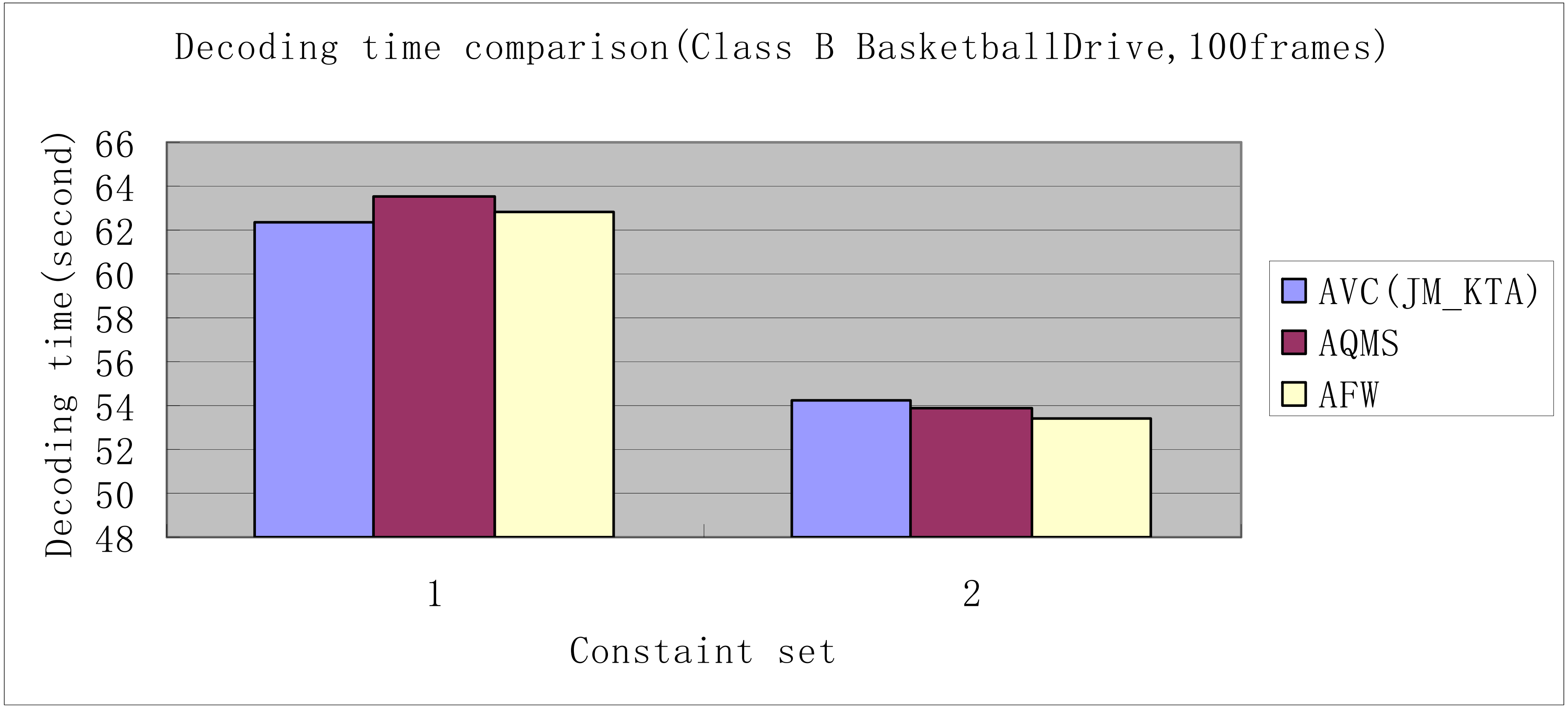
Table 2 Decoding time comparison

		DecodingTime(second)			DecodingTime(times)		
	QP	JM	AFWQ	AQMS	AFWQ_vs_JM	AQMS_vs_JM	AQMS_vs_AFWQ
alpha	25	64.071	63.808	64.981	0.996	1.014	1.018
	27	62.863	64.189	64.732	1.021	1.030	1.008
	30	63.407	63.721	64.421	1.005	1.016	1.011
	33	61.595	61.988	63.233	1.006	1.027	1.020
	38	60.034	60.306	60.229	1.005	1.003	0.999
beta	27	54.241	55.925	55.169	1.031	1.017	0.986
	30	60.488	54.394	54.775	0.899	0.906	1.007
	33	53.647	54.098	54.003	1.008	1.007	0.998
	37	52.039	51.879	54.315	0.997	1.044	1.047
	40	50.898	50.676	50.868	0.996	0.999	1.004

[1] Xeon X5460 3.16GHz, 16GB RAM, Windows XP professional x64 edition. SP2 (x64), BasketballDrive_1920x1080_50

The decoding time of AFWQ is not observed increasing comparing to the KTA JM anchor.

Complexity analysis



The decoding time of AFWQ is not observed increasing comparing to the KTA JM anchor.

Conclusions

- Parameterized frequency weighting models in picture/slice level
- Non–uniform quantization in macroblock level to adaptive to the local textures.
- Fewer bits used in picture level and no extra bits needed in macroblock.
- One pass quantization tool, low complexity for both encoder and decoder.

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Thank you!