

JCTVC-B059

Adaptive Frequency Weighting Quantization in Macroblock level

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Outline

- **Motivation**
- **Parameterized frequency weighting**
- **Adaptive quantization mode selection**
- **Experimental Results**
- **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.

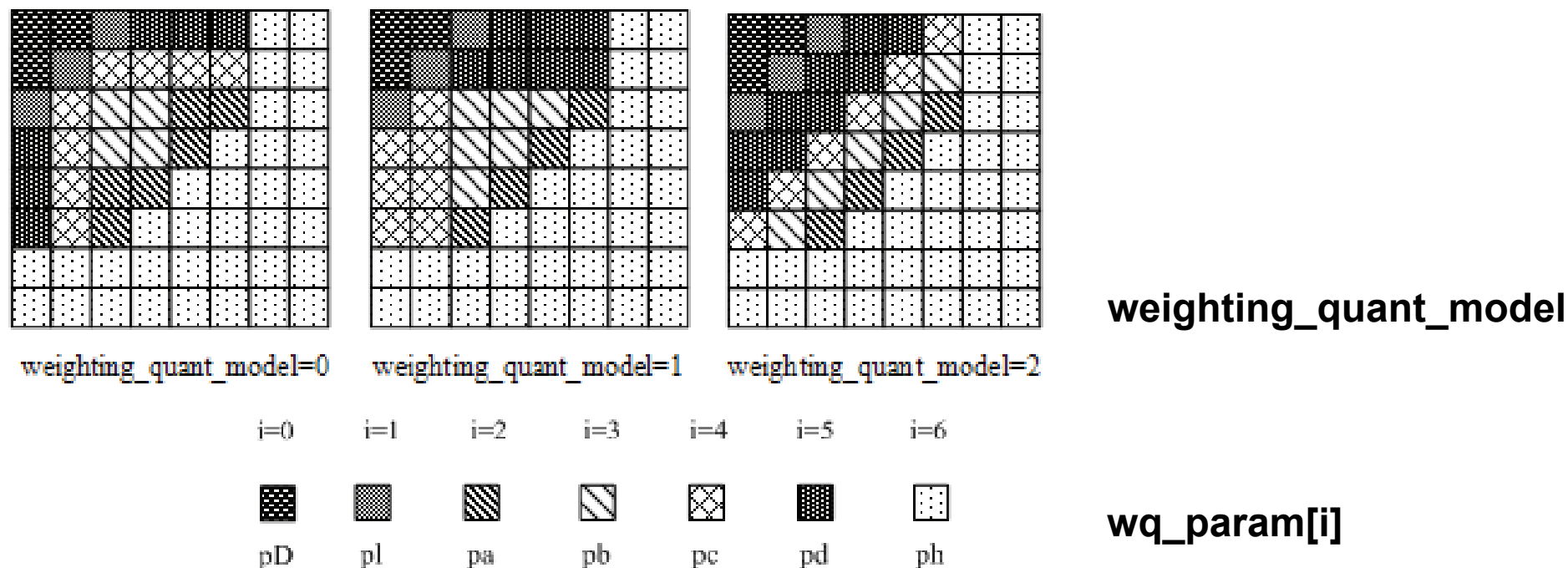
Previous work

Several CFP response proposals in the Dresden meeting reported the improved quantization tools/matrix for better subjective and/or objective performance.

- Subjective Adaptive Quantization Matrix Selection in JCTVC-A117 (Toshiba),**
- Soft Decision Quantization (SDQ) in JCTVC-A120 (RIM),**
- Adaptive Frequency Weighting Quantization in JCTVC-A111 and JCTVC-A028 (Hisilicon/Huawei)**
- Subjective improved quantization matrix in JCTVC-A114(France Telecom, NTT, NTT DoCoMo, Panasonic and Technicolor)**

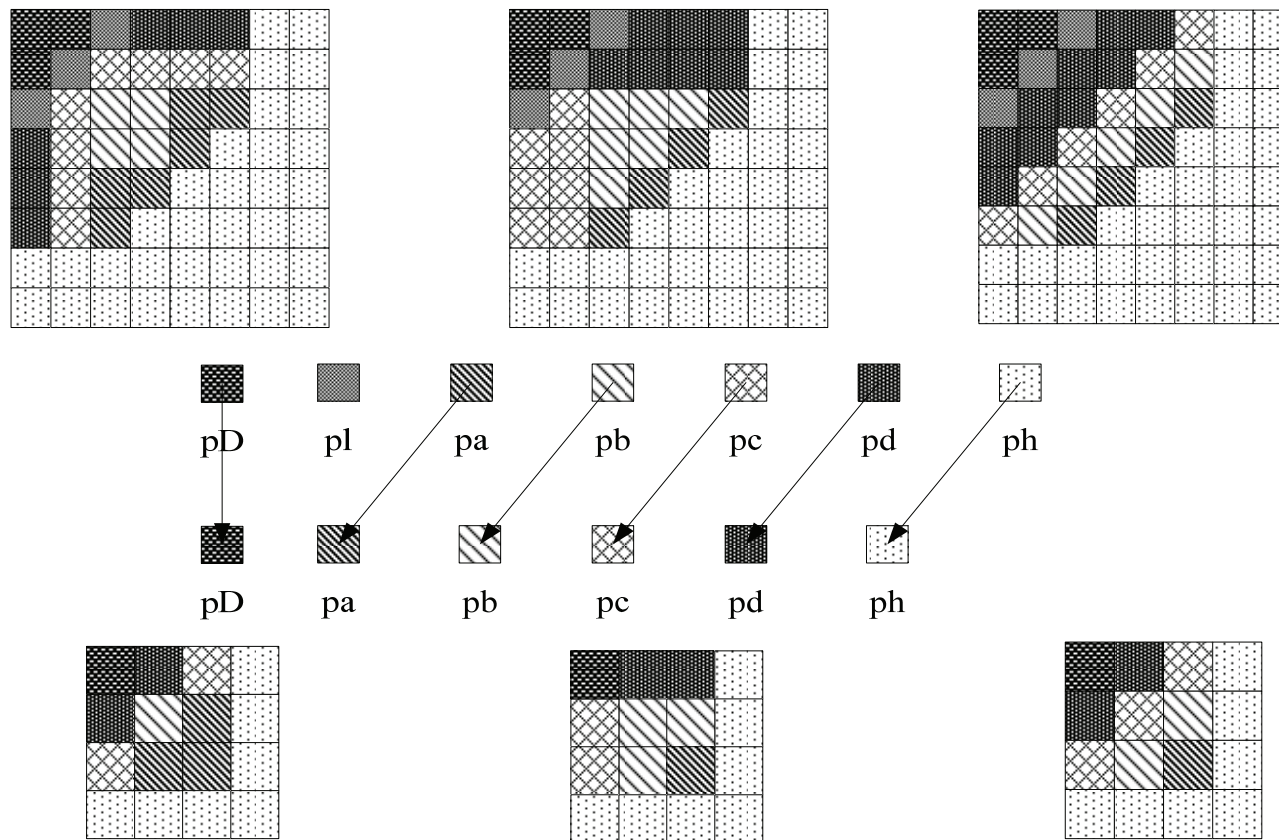
Parameterized frequency weighting

every frequency band has a corresponding weighting factor, $wq_param[i]$ ($i=0\dots6$), and each frequency band distribution can be modeled and indicated by $weighting_quant_model$ ($weighting_quant_model = 0, 1, 2$).



Frequency band weighting model

Parameterized frequency weighting



Frequency band weighting model

Parameterized frequency weighting

Beneficial features for using this model in quantization

- **An easy way to control the subjective quality by changing the frequency band weighting factors for each encoded picture.**
- **Lower bit overhead in picture/slice header without storing the whole matrix. Frequency band weighting parameters are share in distribution model for different block-size transform, and reduce the bit overhead in picture header.**
- **Frequency band weighting can be treated as a certain of fractional quantization level instead of a fixed integer quantization level over the whole block. It therefore can bring block artifacts reduction when different quantization level is applied to the block edges or object edge is splited into different blocks.**

Parameterized frequency weighting



proposal@241.01k



JM-KTA@251.58k

Parameterized frequency weighting



proposal@241.01k



JM-KTA@251.58k

Adaptive quantization mode selection

(1) Quantization mode 0:

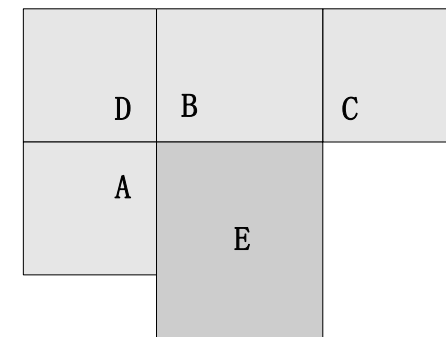
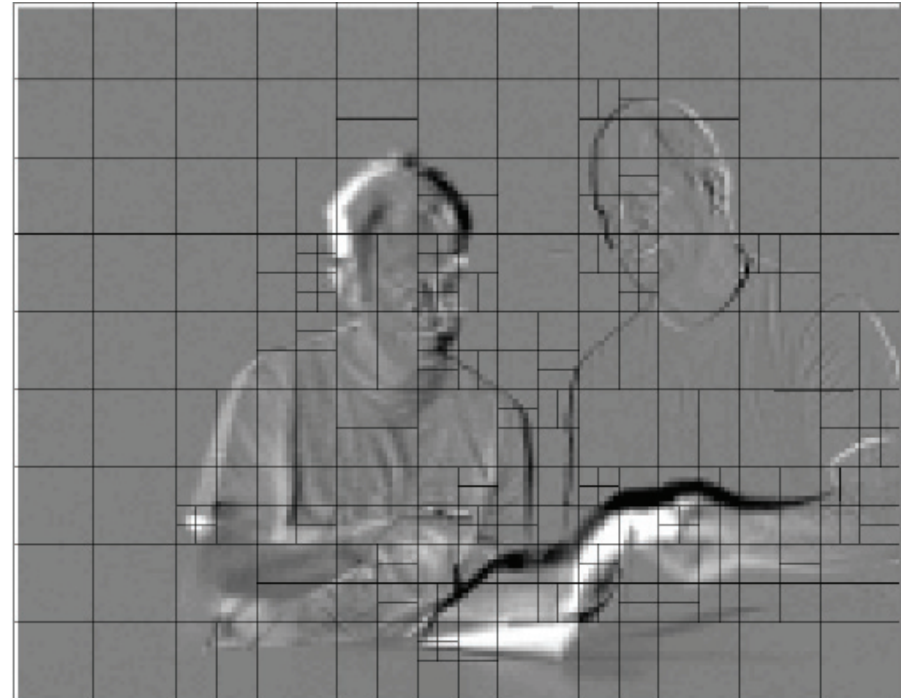
Default quantization mode, flat quantization

(2) Quantization mode 1:

Details-preserving mode, the quantized/dequantized block would preserve image texture details as more as enough.

(3) Quantization mode 2:

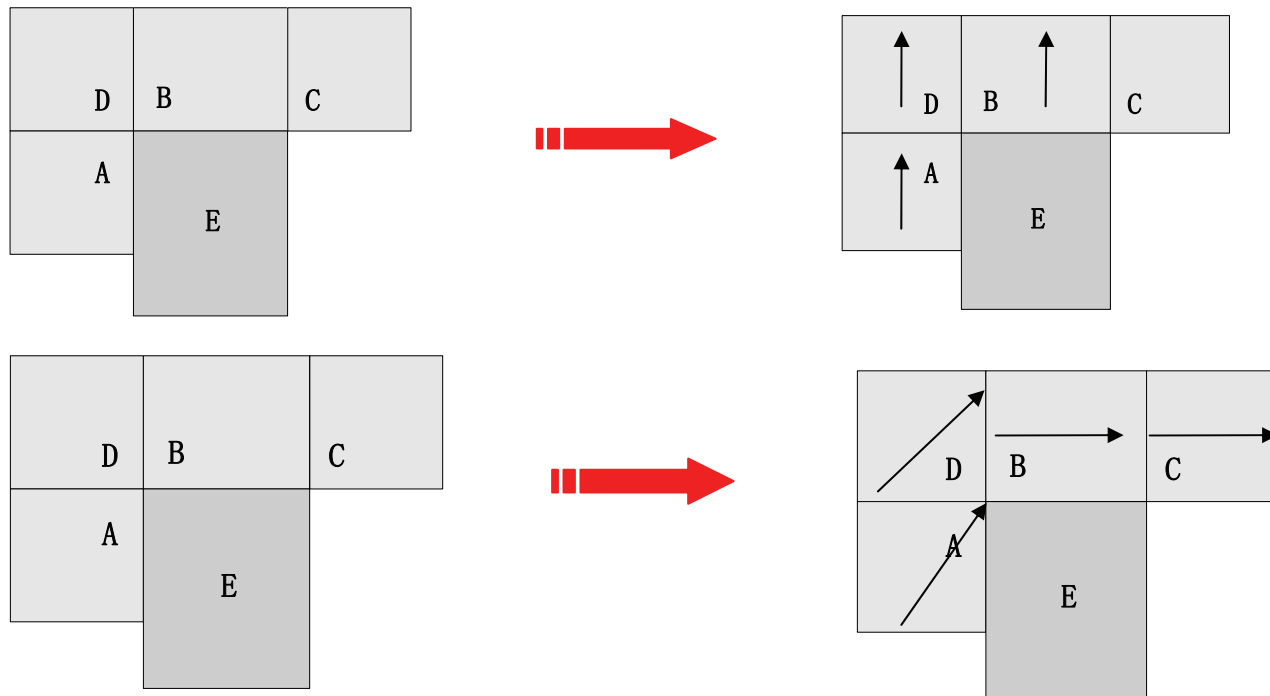
Undetailed quantization mode, the quantized/ dequantized block would not preserve texture details more.



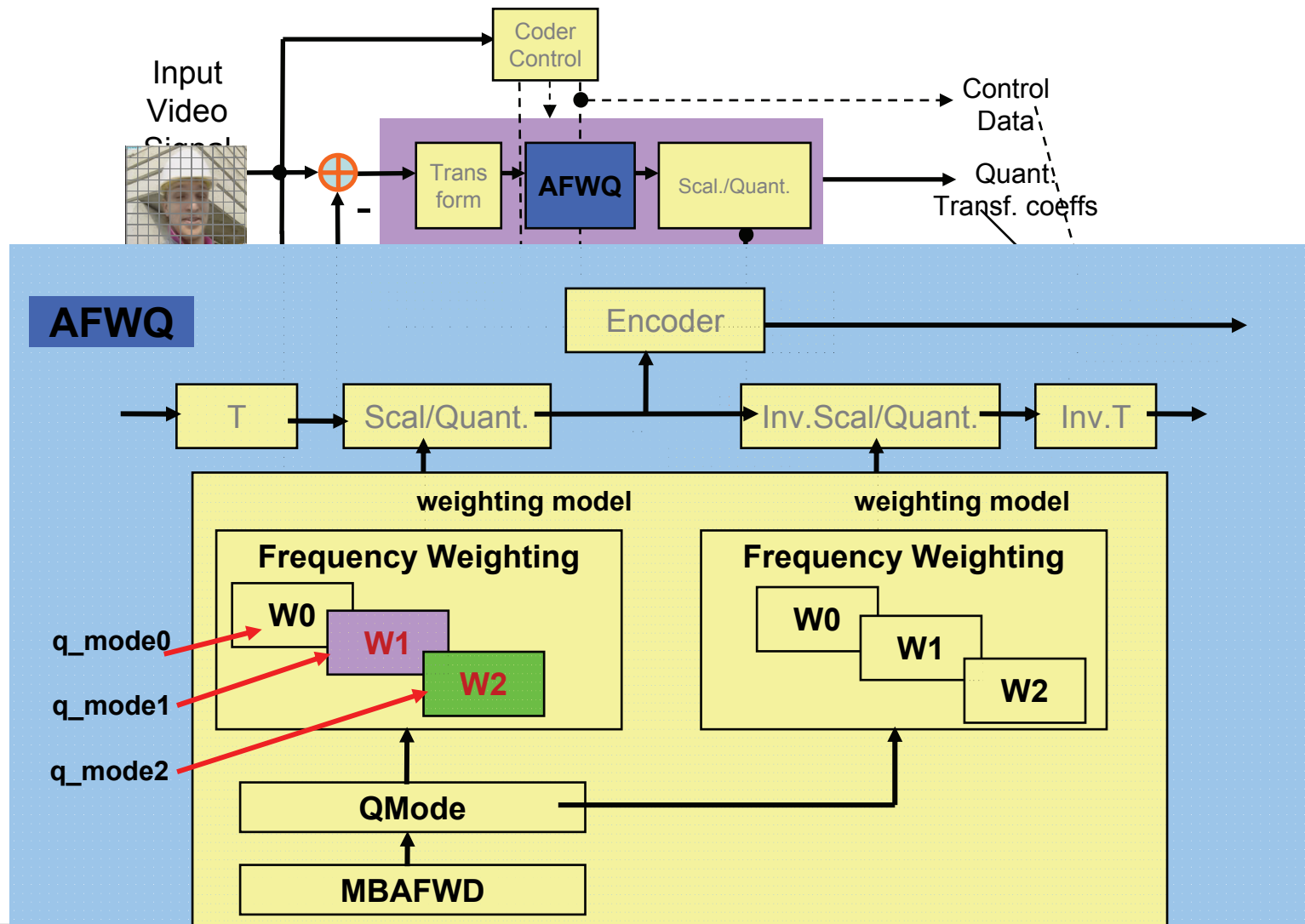
Adaptive quantization mode selection

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

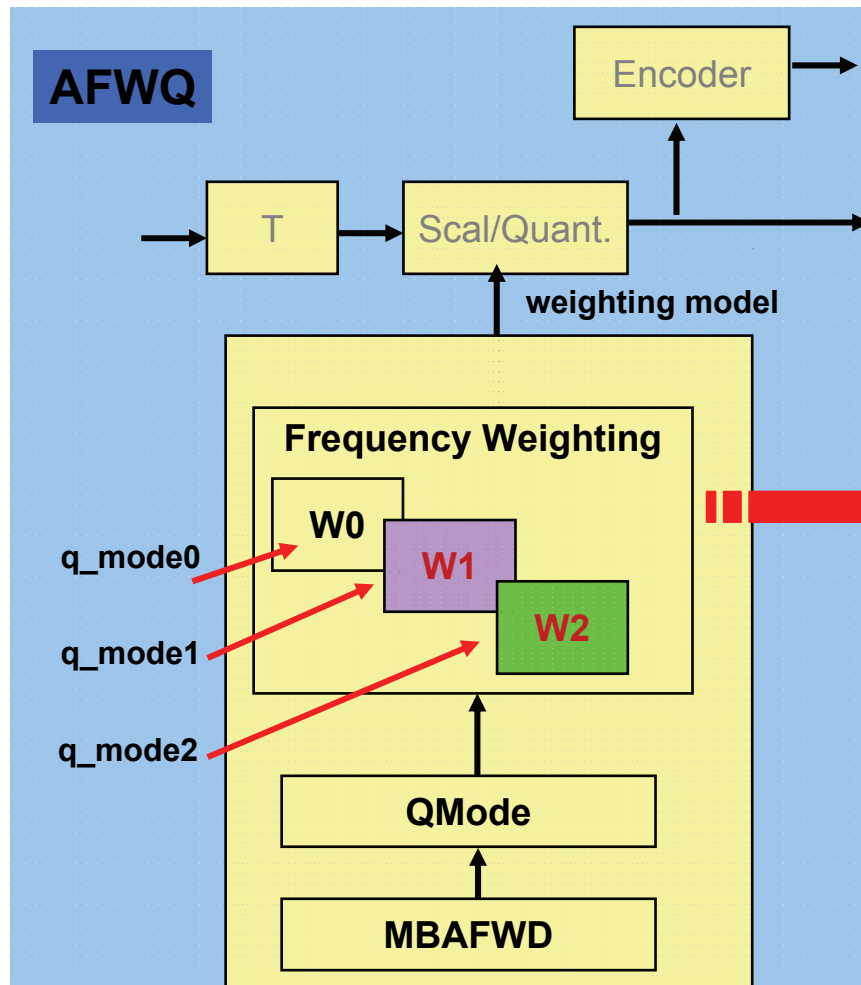
inter-coding Inter prediction mode (block type and block size) of neighbor blocks may be used in the quantization mode selection



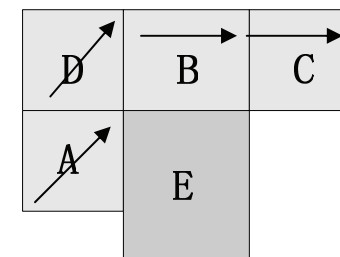
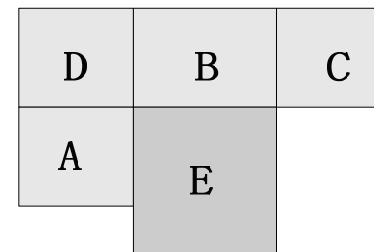
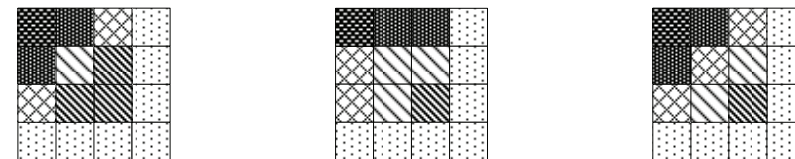
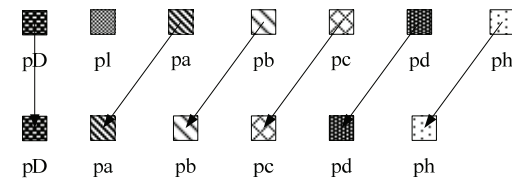
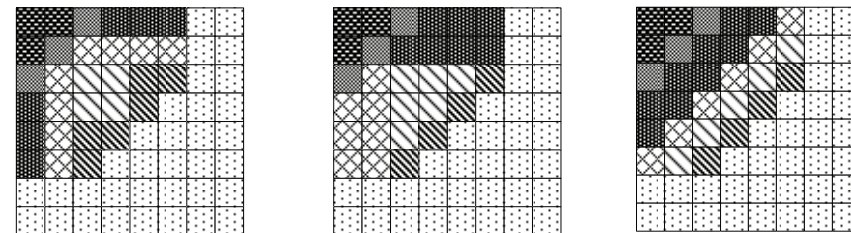
Adaptive Frequency Weighting Quantization (AFWQ)



Adaptive Frequency Weighting Quantization (AFWQ)

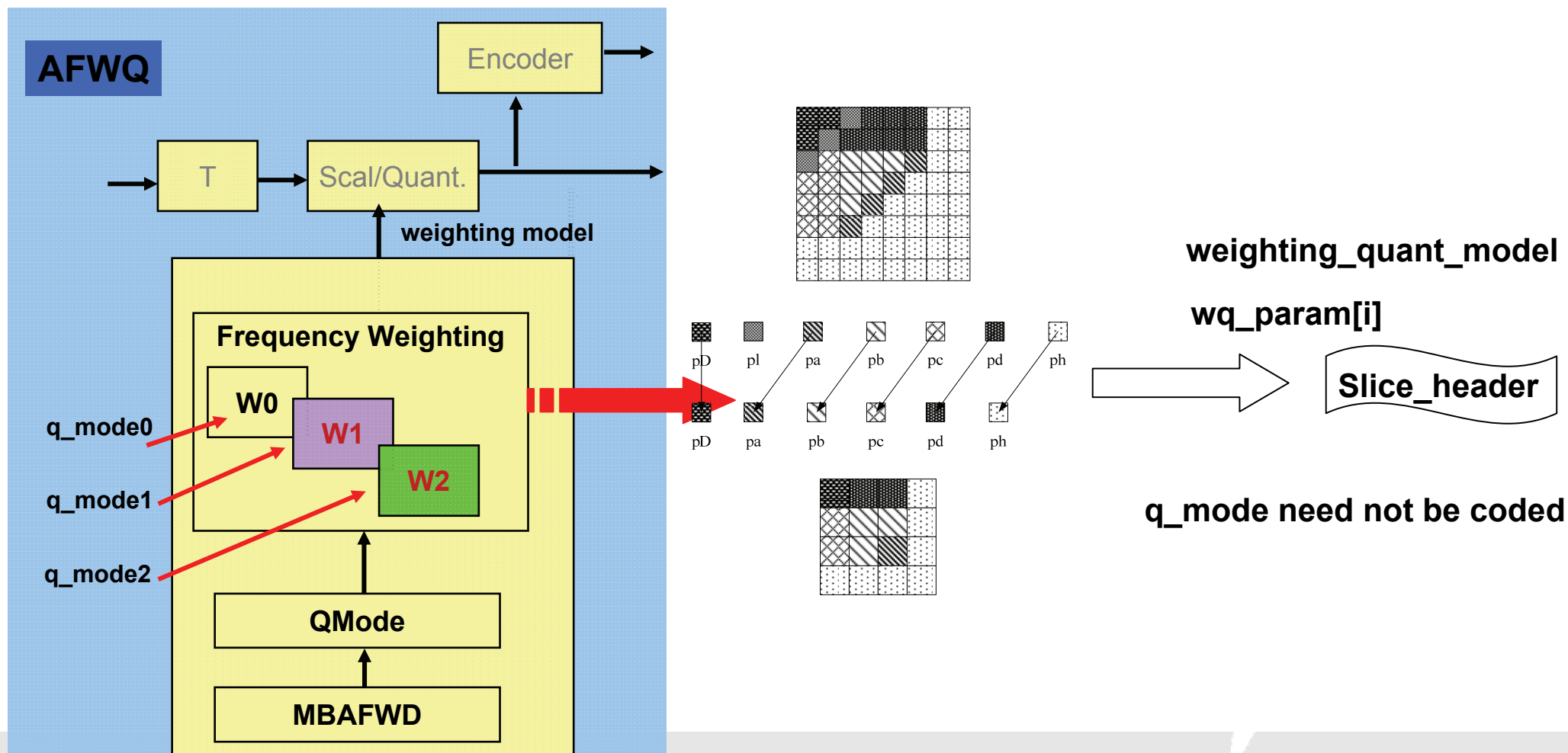


Frequency band weighting model



Adaptive Frequency Weighting Quantization (AFWQ)

Encoder



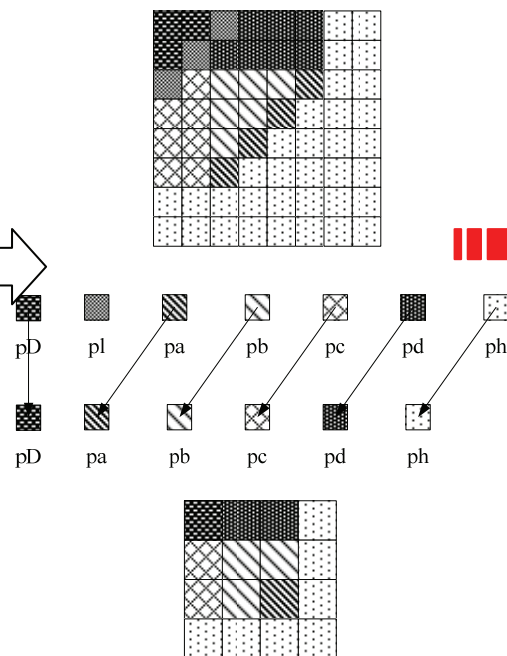
Adaptive Frequency Weighting Quantization (AFWQ)

Decoder

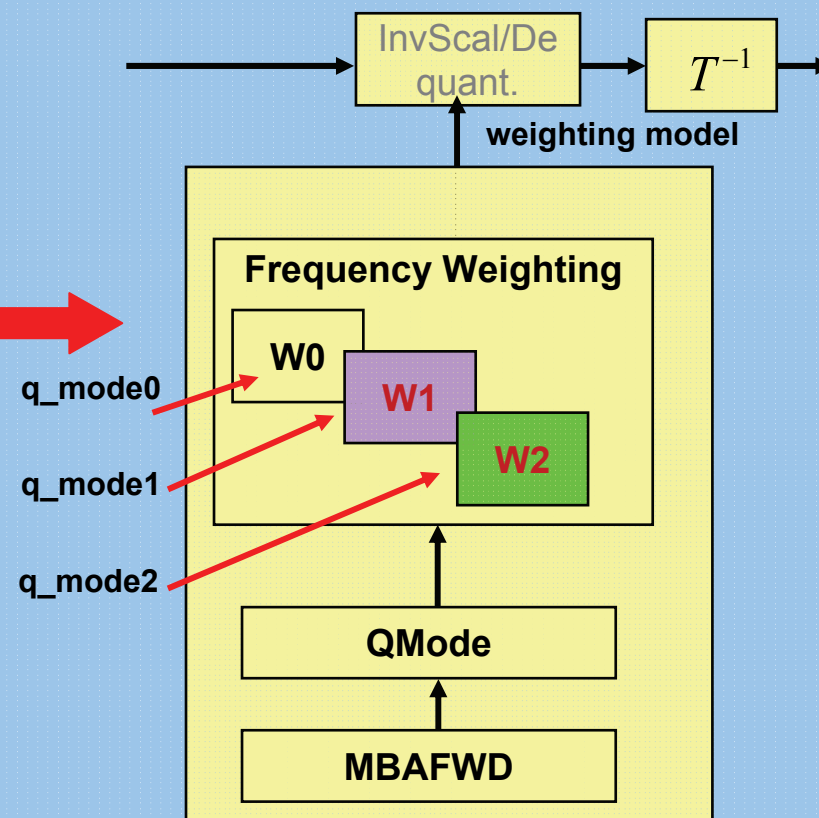
weighting_quant_model

wq_param[i]

Slice_header



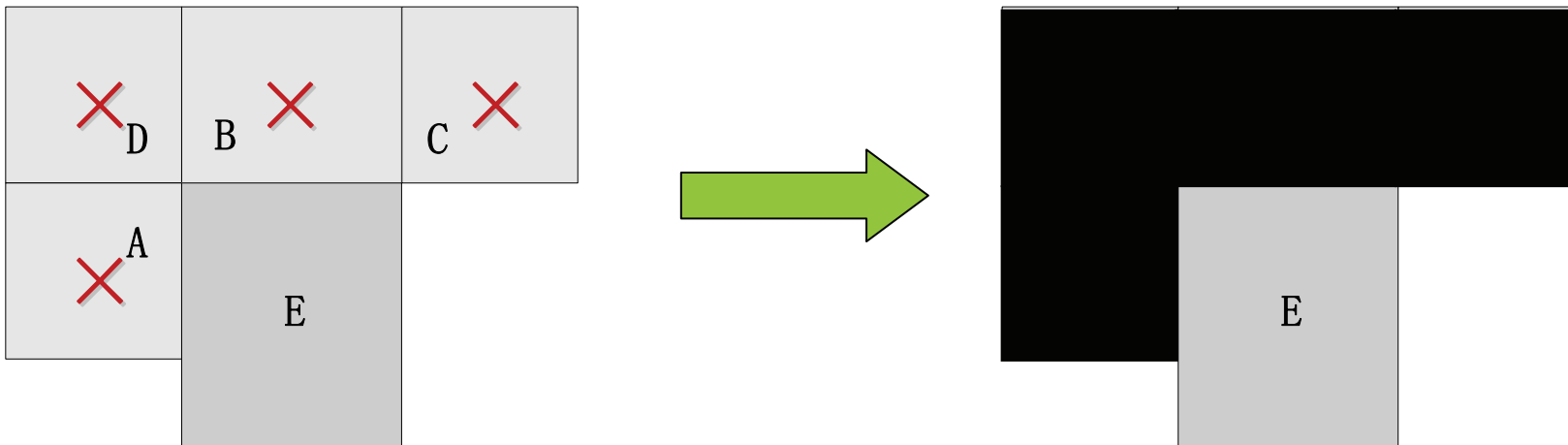
AFWQ



Adaptive quantization mode selection

For boundary macroblock (first column and first row)

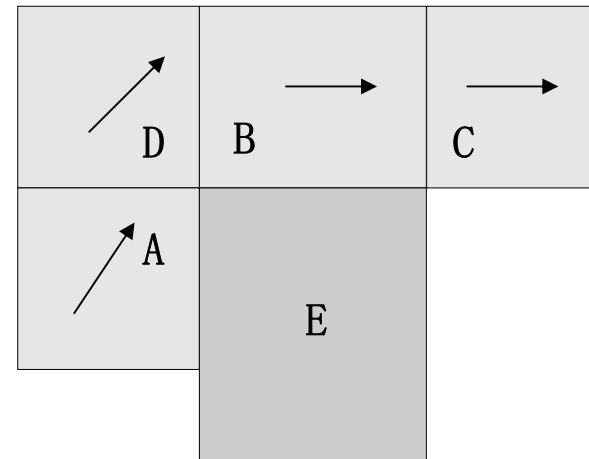
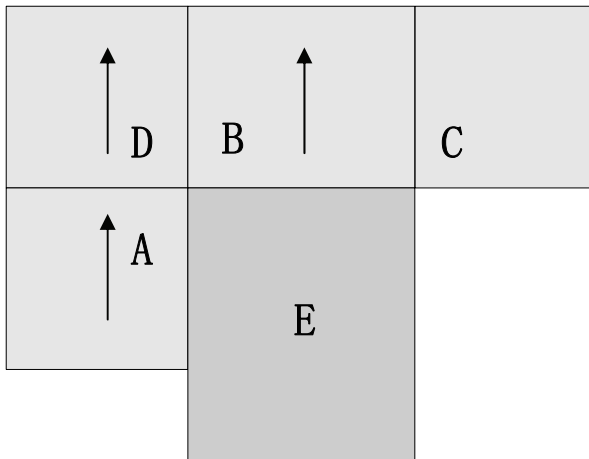
- if either A,B,C or D is not available, quantization_mode of E is derived as
 - I_SLICE macroblock, quantization_mode is set equal to q_mode_1;
 - P_SLICE macroblock, quantization_mode is set equal to q_mode_0;
 - B_SLICE macroblock, quantization_mode is set equal to q_mode_2;



Adaptive quantization mode selection

For intra picture— intra_prediction_mode, mb_type,

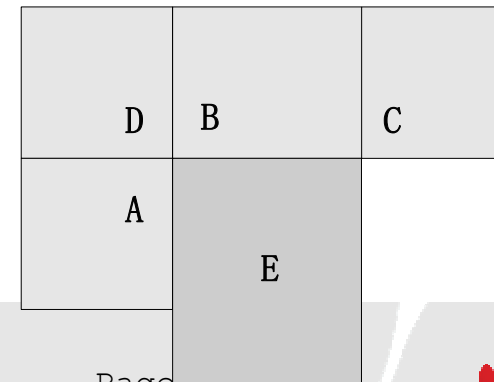
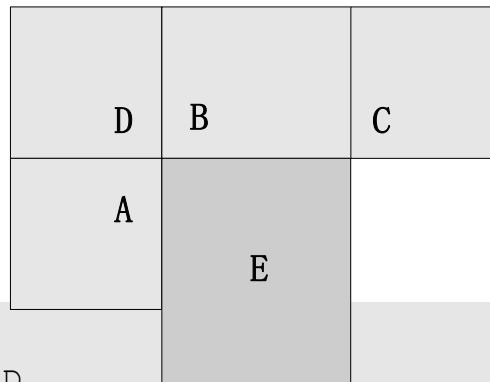
- -if mb_type for either A,B,C or D is equal to I_4x4, quantization mode for E is set equal to q_mode_1;
- - else if mb_types for A and B are both I_16x16, and mb_types for A and D are both I_16x16, quantization mode for E is set equal to q_mode_0;
- - else if intra_predict_mode of A and B are same mode, and intra_predict mode of A and D are same mode, quantization mode for E is set equal to q_mode_0; - else quantization mode for E is set equal to q_mode_1.



Adaptive quantization mode selection

For P picture— mb_type,

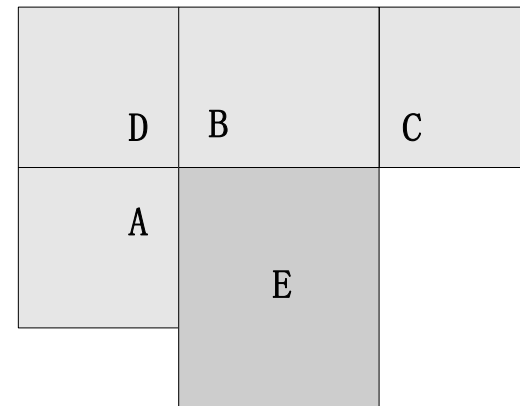
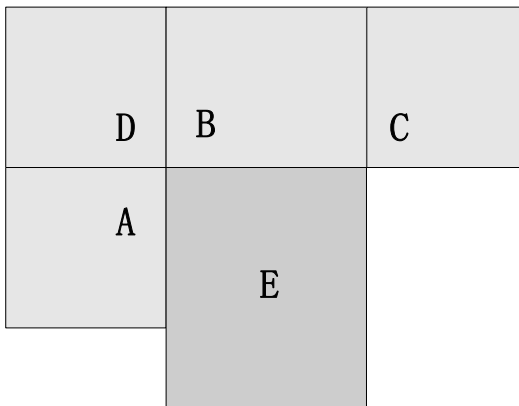
- - if mb_type for either A,B,C or D is equal to P_4x4, quantization mode for E is set equal to q_mode_1; else
- - if mb_type for either A,B,C or D is equal to P_8x8, if reference picture, quantization mode for E is set equal to q_mode_0, else quantization mode for E is set equal to q_mode_2;
- - if mb_type for A and D are P_Skip mode, or mb_type for B and D are P_Skip mode, or mb_type for A and B are P_Skip mode, if reference picture, quantization mode for E is set equal to q_mode_1, else quantization mode for E is set equal to q_mode_2;
- - if mb_type for A is P_16x8, and mb_type for B is P8x16, if reference picture, quantization mode for E is set equal to q_mode_1,else quantization mode for E is set equal to q_mode_2;
- - if mb_type for either A,B or D is P16x16, quantization mode for E is set equal to q_mode_2;
- - else if reference picture, quantization mode for E is set equal to q_mode_0,else quantization mode for E is set equal to q_mode_2;



Adaptive quantization mode selection

For B picture— mb_type,

- - if mb_type for either A,B,C or D is equal to B_8x8, if reference picture, quantization mode for E is set equal to q_mode_0,else quantization mode for E is set equal to q_mode_2;
- - if mb_type for A and D are B_Skip mode, or mb_type for B and D are P_Skip mode, quantization mode for E is set equal to q_mode_2;
- - if mb_type for A and D are B_16x16 mode, or mb_type for B and D are B_16x16 mode, quantization mode for E is set equal to q_mode_2;
- - else quantization mode for E is set equal to q_mode_2.



Syntax

C

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)
}		
}		

Experimental Results

- anchor: KTA2.6 r1 AVC
- The QP points setting are fixed QPs as same as the configuration in the Alpha anchor bitstreams.
- three quantization modes(0~2) are used
- Constraint 1
- RDOQ QP_NUM=1

Experimental Results

anchor: KTA2.6 r1 AVC

CS1 (random access)	High rate		Low rate		Average	
Class C_WVGA	Bitrate Saving	PSNR Gain	Bitrate Saving	PSNR Gain	Bitrate Saving	PSNR Gain
PartyScene	-3.90	0.15	-4.83	0.18	-4.36	0.16
BQMall	-2.31	0.11	-2.61	0.14	-2.46	0.12
BasketballDrill	-4.65	0.19	-5.18	0.23	-4.91	0.21
RaceHorses	-1.71	0.07	-2.33	0.10	-2.02	0.08
average	-3.14	0.13	-3.74	0.16	-3.44	0.14

Experimental Results

anchor: KTA2.6 r1 AVC

CS1 (random access)	High rate		Low rate		Average	
Class B_1080P	Bitrate Saving	PSNR Gain	Bitrate Saving	PSNR Gain	Bitrate Saving	PSNR Gain
Kimono1	-2.88	0.09	-3.35	0.13	-3.11	0.11
Cactus	-3.32	0.09	-3.82	0.12	-3.57	0.11
BasketballDrive	-2.14	0.06	-2.64	0.09	-2.39	0.08
ParkScene	-3.31	0.12	-3.18	0.12	-3.24	0.12
BQTerrace	-2.61	0.04	-2.90	0.06	-2.75	0.05
ChristmasTree	-1.20	0.04	-1.87	0.07	-1.54	0.05
Wisley2	-4.38	0.17	-4.29	0.17	-4.34	0.17
average	-2.84	0.09	-3.15	0.11	-2.99	0.10

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 bits overhead in macroblock.
- One pass quantization tool, low complexity for both encoder and decoder.

The proposal suggests using parameterized frequency weighting and adaptive quantization mode selection features in HEVC Test model.

Thank you!
