MODEL-INDEPENDENT RATE CONTROL FOR INTRA-CODING BASED ON PIECEWISE LINEAR APPROXIMATIONS

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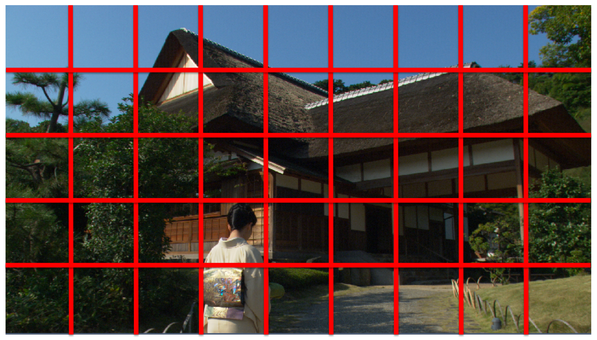
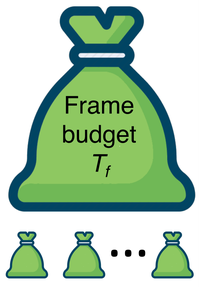
Rate Control in HEVC Intra-coding

Less compression → rate control (RC)

More compression → RC





T_{CU} : budget of current coding unit (CU)

coding cost of current CU

bits left in T_f

$$T_{CU} = \frac{HAD_{CU}}{HAD_f - \widehat{HAD_f}}\omega$$

cost of all CUs in frames

cost of coded CUs in frame

Quantization parameter (QP) for each CU? → model to approximate slope (λ) of rate-distortion (RD) curve

$$\lambda_{CU} = \alpha(HAD_{CU}/T_{CU})^{\beta}$$

$$QP_{CU} = 4.2005 ln\lambda_{CU} + 13.7122$$

$\{\alpha, \beta\}$: R-λ model's parameters → fixed for all CUs

Proposed RC Algorithm

Linear piecewise segments to approximate λ_{CU} and QP_{CU}: interpolate among $N > 2$ control points.

Control point: actual rate, QP and distortion values of a previously coded CU, b, in same frame.

$$(1-\rho)\mathrm{HAD}_b \leq \mathrm{HAD}_{CU} \leq (1+\rho)\mathrm{HAD}_b$$

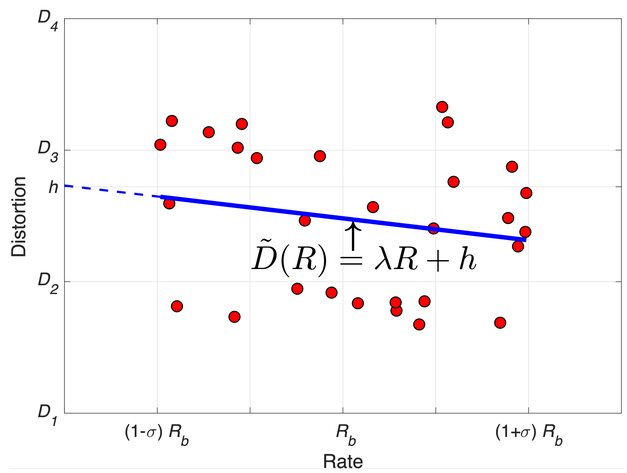
constants $\ll 1$

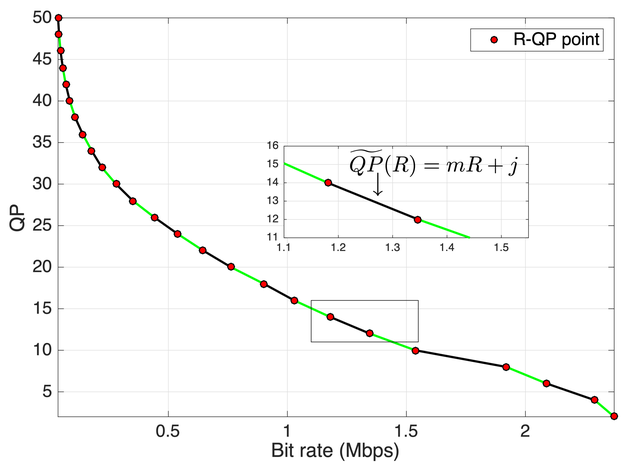
coding cost of CU b

$$(1-\sigma)R_b \leq \hat{R}_{CU} \leq (1+\sigma)R_b$$

actual rate of CU b

target rate of current CU





Performance Evaluation

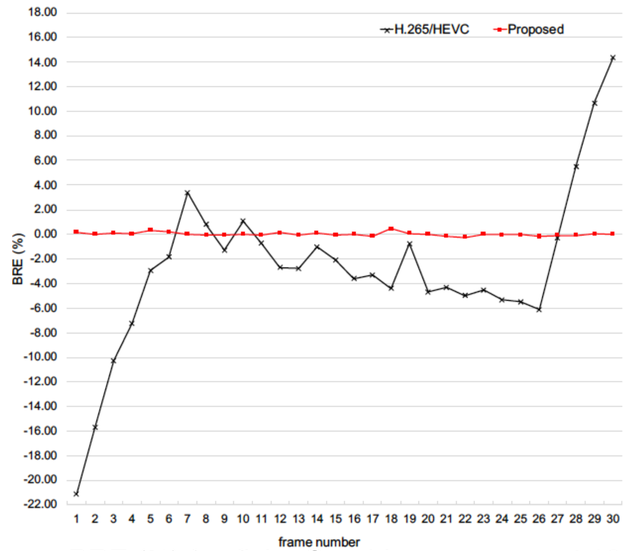
RC algorithm embedded into H.265/HEVC encoder (HM16.8]). AI profile with largest CU of 64×64 samples.

Bit rate error (BRE - %): negative numbers → underspending bit budget, positive numbers → overspending bit budget.

Average absolute BRE values reported over four different target bit rates (see Table 1).

Table 1. BRE (%) values.

Sequence	R-λ			Proposed		
	|Avg|	Min	Max	|Avg|	Min	Max
class SC						
flyingGraphics	2.23	-7.69	1.81	0.08	-0.92	0.97
map	1.34	-5.29	6.32	0.87	-1.08	1.01
missionCtrlClip3	4.89	-11.56	1.47	0.10	-0.32	0.02
class F						
slideShow	2.31	-2.45	2.10	0.21	-0.03	0.08
slideEditing	0.68	-1.34	0.98	0.03	-0.02	0.02
chinaSpeed	1.03	0.13	1.03	0.02	0.01	0.02
class NC						
kimono	0.03	-0.04	0.01	0.01	0.00	0.01
parkScene	0.02	-0.02	0.01	0.01	0.00	0.01



Per-frame BRE (%) for *flyingGraphics* sequence at 18 Mbps.