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VCEG-AI19

Improvement of AQMS

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Summary

- **Explain the difference between QP and QM**
  - QM can change quant step size at each frequency position.
- **Propose Improved AQMS (IAQMS)**
  - Predefined QM → Not need design process
  - 4 QMs for I,P-slice and 2 QMs for B-slice
  - Introduction of reusing results of ME and mode decision
- **Experimental results**
  - 5.1% gain on average with IAQMS
  - 8.6% gain on average with IAQMS and RDOQ
  - 2.0% gain on average compared to RDOQ anchor
  - 15% reduction of encoding time increase compared to KTA1.9 AQMS

Background

- **AQMS (Adaptive Quantization Matrix Selection)**
  - Selecting one optimal quantization matrix (QM) at each macroblock from either the flat QM or a specific QM which is designed at each picture.
  - Fast encoding technique was proposed at last meeting.

- **Non-normative optimization tools**
  - Adaptive QP
  - RDO_Q

    (Combination of Adaptive QP and Trellis based R-D Optimized Quantization)

H.264 Quantization

Formulation of H.264 Quantization

$$Z_{ij} = round(W_{ij} \times LevelScale(i, j, m)) >> (qbits)$$

$$LevelScale(i, j, m) = (NormAdjust(i, j, m) << 4) / QM(i, j)$$

$$qbits = 15 + floor(QP / 6)$$

$$m = QP\%6$$

Z_{ij} : Quantized Coeff

W_{ij} : Transform Coeff

ΔQP : deltaQP

QP : Quantization Parameter

QM : Quantization Matrix

Relation of QP and QM

$$\Delta QP = QP - baseQP$$

$$\Delta QP = \log_2\left(QM(i, j) >> 4\right) \times 6$$

Difference of QP and QM

$$QP = baseQP + \Delta QP$$

Case A) *baseQP* = 16, *QM*(*i*,*j*) = **Flat**

$$\mathbf{QM}^A(i,j) = \begin{bmatrix} 16 & 16 & 16 & 16 \\ 16 & 16 & 16 & 16 \\ 16 & 16 & 16 & 16 \\ 16 & 16 & 16 & 16 \end{bmatrix} \Rightarrow \Delta\mathbf{QP}^A(i,j) = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Case B) *baseQP* = 16, *QM*(*i*,*j*) = **slope**

$$\mathbf{QM}^B(i,j) = \begin{bmatrix} 16 & 17 & 18 & 19 \\ 17 & 18 & 19 & 20 \\ 18 & 19 & 20 & 21 \\ 19 & 20 & 21 & 22 \end{bmatrix} \Rightarrow \Delta\mathbf{QP}^B(i,j) = \begin{bmatrix} 0 & 6\times\log_2\frac{17}{16} & 6\times\log_2\frac{18}{16} & 6\times\log_2\frac{19}{16} \\ 6\times\log_2\frac{17}{16} & 6\times\log_2\frac{18}{16} & 6\times\log_2\frac{19}{16} & 6\times\log_2\frac{20}{16} \\ 6\times\log_2\frac{18}{16} & 6\times\log_2\frac{19}{16} & 6\times\log_2\frac{20}{16} & 6\times\log_2\frac{21}{16} \\ 6\times\log_2\frac{19}{16} & 6\times\log_2\frac{20}{16} & 6\times\log_2\frac{21}{16} & 6\times\log_2\frac{22}{16} \end{bmatrix}$$

QM can change the quantization step size at each frequency position.

Improvement of AQMS (IAQMS)

- **Specification changes**
  - Predefined QM → Deletion of QM design process
  - Number of QM
    - 4 kinds of QM for I,P-Slice
    - 2 kinds of QM for B-Slice
- **Optimization of encoder implementation**
  - Reuse the results of motion estimation and mode decision

Experimental conditions

Common coding conditions based on VCEG-AE10r1

Coding Tools	Anchor (VCEG-AE10r1)	RDOQ	IAQMS/ KTA1.9 AQMS*
Software	KTA software version 1.9		
Profile	High profile		
Coding Structure	IBBP (M=3)		
Quant Param (QP)	Fix QPI=(22,27,32,37), QPP=QPI+1, QPB=QPP+1	Adaptive (Selected by Adaptive QP)	Fix QPI=(22,27,32,37), QPP=QPI+1, QPB=QPP+1
Scaling Lists (QM)	Flat	Flat	Flat or Weighted (Selected by AQMS)

- Apply same QM for luma and chroma components.

KTA1.9 AQMS : Fast AQMS “UseAdaptiveQuantMatrix=2”

Experimental results of KTA1.9 AQMS and IAQMS

Seuqences	Size	Coding efficiency for IBBP (Δbitrate)	
		KTA1.9 AQMS (%)	IAQMS (%)
container_qcif	QCIF	3.15	4.64
foreman_qcif		3.63	3.88
silent_qcif		8.29	8.39
QCIF Average		5.03	5.64
foreman_cif	CIF	3.42	3.54
mobile_cif		5.67	5.99
paris_cif		5.35	7.66
tempete_cif		5.28	5.20
CIF Average		4.93	5.60
BigShips	720p	3.12	4.19
City		2.53	4.43
Crew		2.54	3.17
Night		2.70	4.18
ShuttleStart		5.07	6.15
720p Average		3.19	4.42
Total Average		4.23	5.12

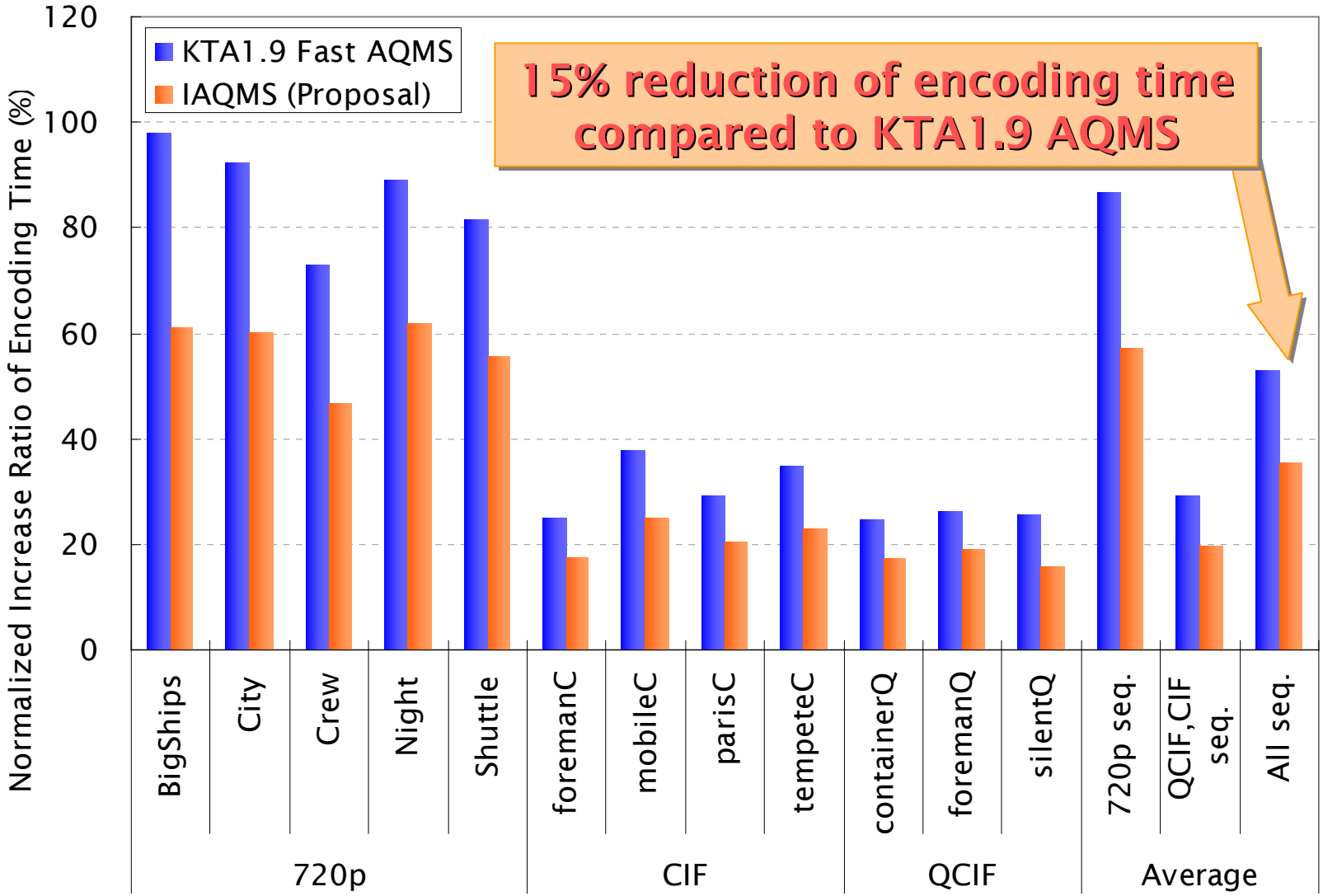
Average 5.12%, 0.9% gain compared to AQMS

Experimental results of combinations

Seuqences	Size	Coding efficiency for IBBP (Δbitrate)		
		RDOQ (%)	KTA1.9 AQMS +RDOQ (%)	IAQMS +RDOQ (%)
container_qcif	QCIF	7.19	8.18	9.17
foreman_qcif		6.82	7.30	8.14
silent_qcif		10.82	11.93	13.34
QCIF Average		8.28	9.14	10.22
foreman_cif	CIF	4.85	5.87	6.66
mobile_cif		7.11	7.95	9.30
paris_cif		9.49	10.98	12.23
tempete_cif		6.96	7.76	8.72
CIF Average		7.10	8.14	9.23
BigShips	720p	4.51	6.33	6.78
City		3.03	4.24	5.14
Crew		5.39	5.81	6.97
Night		5.83	6.30	6.90
ShuttleStart		6.77	8.41	9.75
720p Average		5.11	6.22	7.11
Total Average		6.56	7.59	8.59

Average 8.6%, 2.0% gain compared to RDOQ

Encoding time increase under VCEG conditions



Conclusion

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