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JCTVC-E215/m19735

Prediction-based QP derivation

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Problem on QP coding

- Current spec for QP:
  - Signaled at LCU level
  - Derived based on coding order:
    QP = previous QP + delta QP
- Perceptually-adaptive quantization (AQ)
  - Widely used in real-world applications
  - Based on perceptual sensitivity for human visual system
  - QP should be highly adaptive to each area

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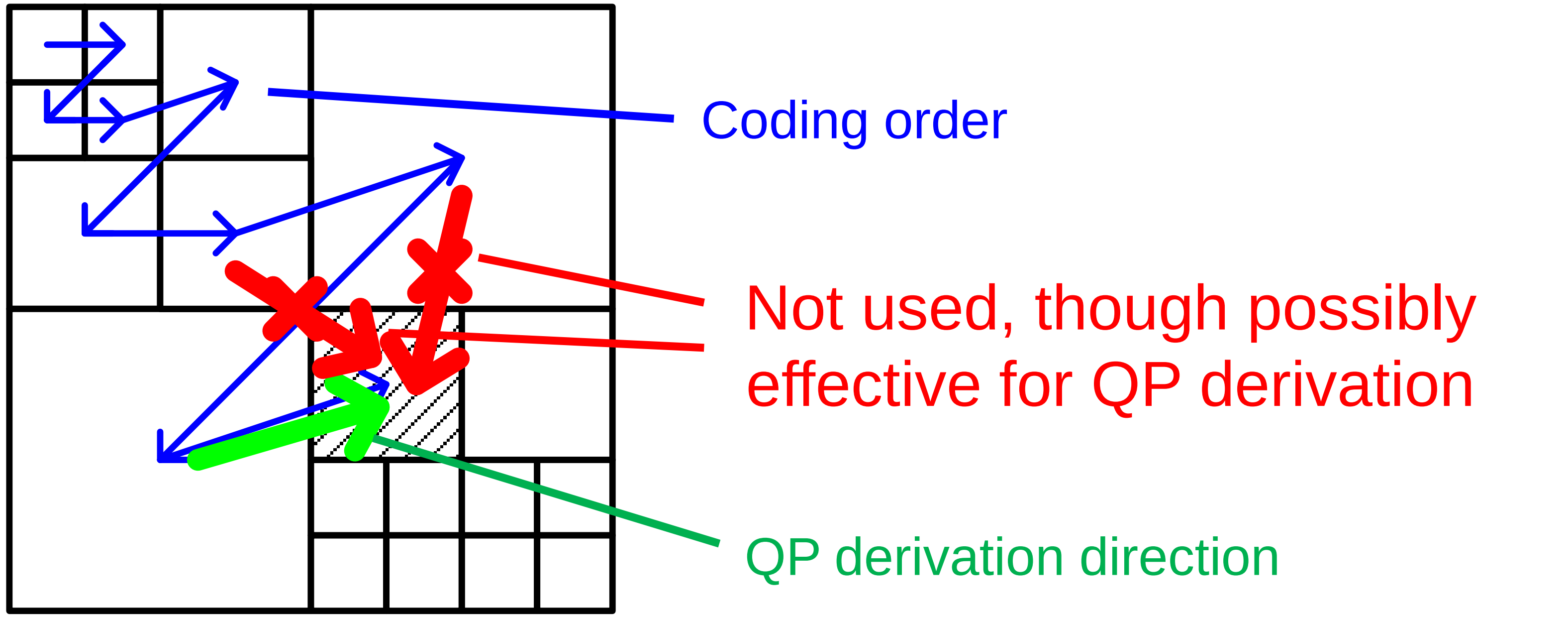
- The current QP spec is insufficient for AQ:
  - On spatial granularity of QP signaling
    -> Sub-LCU level QP signaling is requested from several parties
  - Also possibly on coding efficiency, but not discussed before
    (related proposals: JCTVC-E198, JCTVC-E217, JCTVC-E391)

QP derivation based on coding order

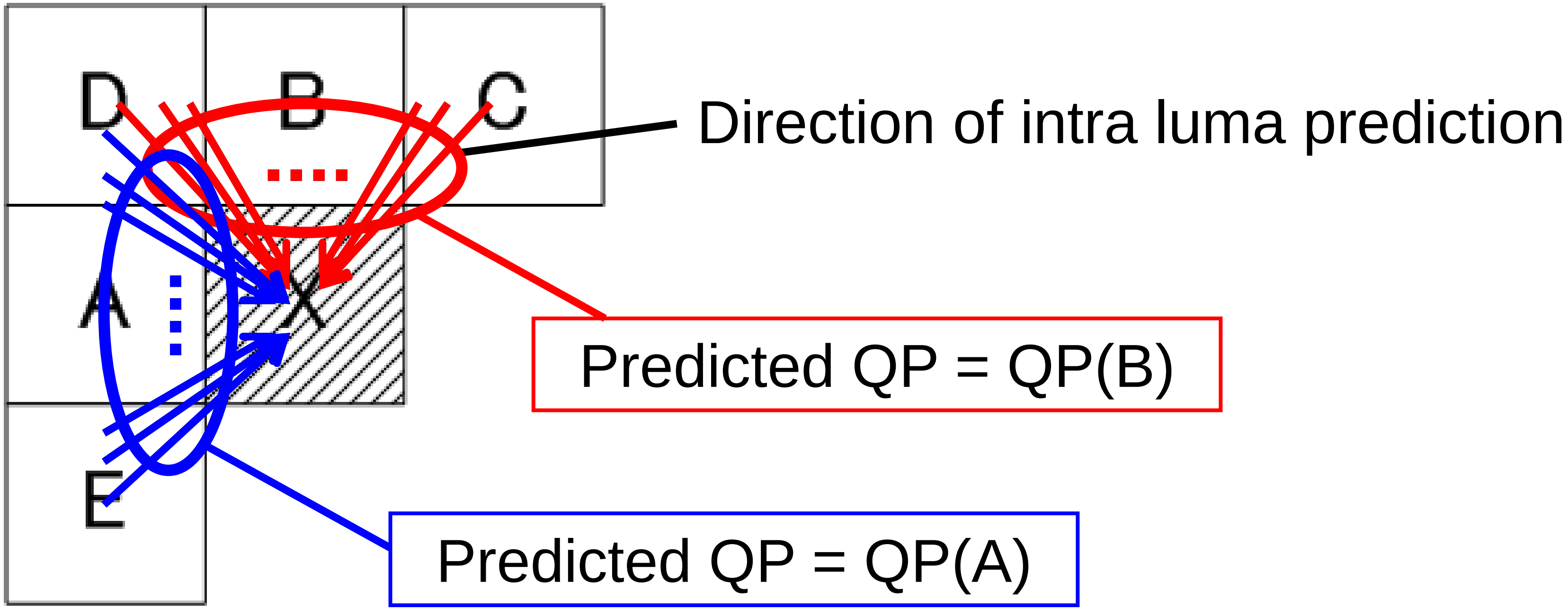
- Widely used in previous standards
  - Also used in WD 2/HM 2.0
- Information in neighboring blocks are not leveraged enough
  - Coding order is independent from texture similarity
  - Intra/inter prediction employs more neighboring blocks

  -> Why not in QP coding?



Proposed QP derivation based on prediction

- Employs neighboring blocks
- For intra-coded CU, QP is predicted along prediction direction
  - Similar QP should be assigned for blocks having similar texture



Proposed QP derivation based on prediction

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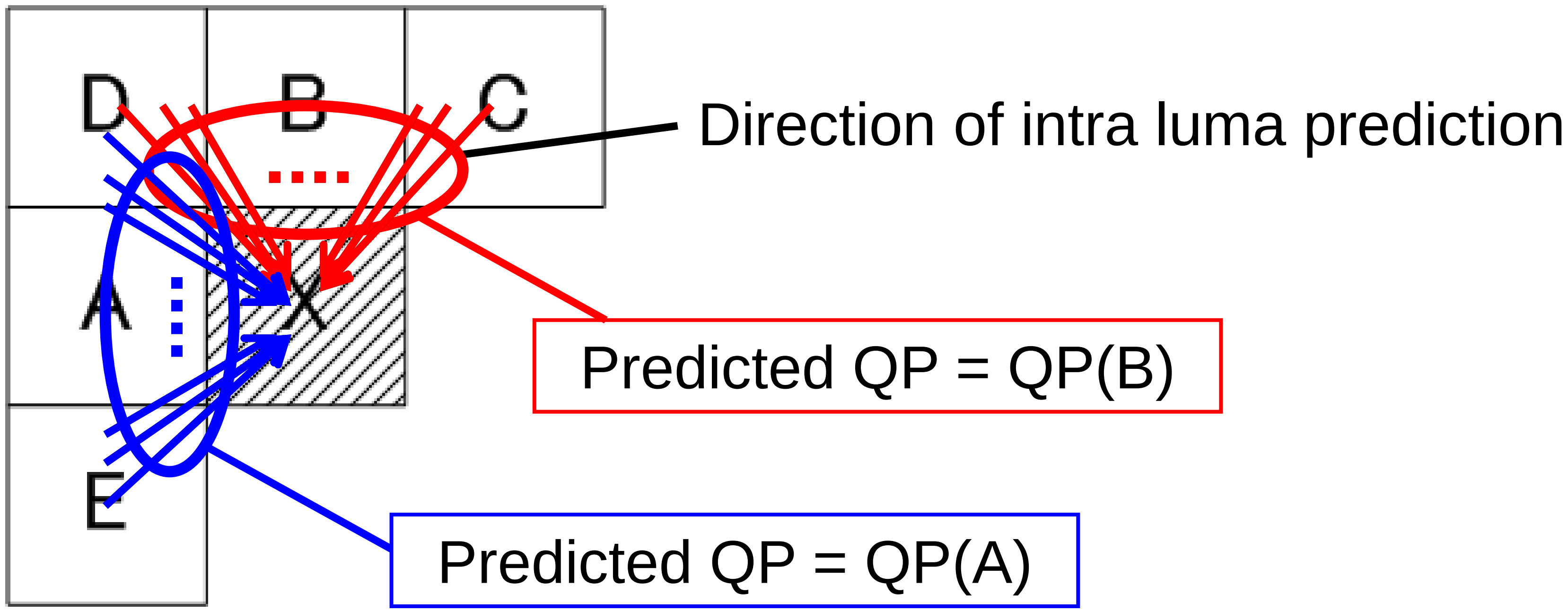

- For other CU, median QP is used
- Top-left-most CU is used for deriving prediction direction, when QP signaling unit size is larger than CU size

Experiments

Software

- Based on HM 2.0
- Modified delta QP signaling (JCTVC-D258) is integrated
- Sub-LCU level QP signaling is integrated
- TM5-like AQ is implemented
  - QP range = [base QP - 6, base QP + 6]
  - Applied both to anchor and to proposal

Test conditions

- 6 conditions defined as common conditions (JCTVC-D600)
- 2 QP signaling levels: LCU-level, CU-level

Evaluation measure

- Coding efficiency by BD metrics
- Complexity by decoding and encoding runtime

Results for CU-level QP signaling

Average BD-Rates (%)

	High Efficiency			Low Complexity		
	Y	U	V	Y	U	V
Intra	-0.5	-0.5	-0.6	-0.9	-1.5	-1.5
Random access	-0.3	-0.3	-0.4	-0.4	-0.8	-0.9
Low delay	-0.2	-0.4	-0.1	0.0	-0.4	-0.3

Average encoding times (%)

	High Efficiency	Low Complexity
Intra	100%	102%
Random access	97%	100%
Low delay	100%	100%

Average encoding times (%)

	High Efficiency	Low Complexity
Intra	100%	100%
Random access	94%	99%
Low delay	100%	100%

Coding gain is achieved with almost no additional complexity

Results for LCU-level QP signaling

Average BD-Rates (%)

	High Efficiency			Low Complexity		
	Y	U	V	Y	U	V
Intra	0.0	0.0	0.0	0.0	0.0	0.0
Random access	0.1	0.0	0.1	0.2	0.0	0.1
Low delay	0.2	0.0	-0.3	0.4	0.1	0.2

Average encoding times (%)

	High Efficiency	Low Complexity
Intra	101%	100%
Random access	101%	100%
Low delay	100%	100%

Average encoding times (%)

	High Efficiency	Low Complexity
Intra	103%	100%
Random access	101%	102%
Low delay	100%	101%

No gain is observed for this case

Conclusion

- Prediction-based QP derivation scheme is proposed
- A method using intra prediction direction is presented
- Coding efficiency is improved by the proposed method, when QP is signaled at CU level
  - Low complexity: Intra 0.9%, RA 0.4%, LD 0.0%
  - High efficiency: Intra 0.5%, RA 0.3%, LD 0.0%
  - When QP is signaled at LCU level, no gains are observed
- Complexity introduced by the proposal is negligible

Proposal:

- Define test conditions for evaluation of QP coding efficiency
- Establish a CE on QP coding
- Further investigate this proposal in the CE

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Results for CU-level QP signaling (Median-only)

Average BD-Rates (%)

	High Efficiency			Low Complexity		
	Y	U	V	Y	U	V
Intra	-0.2	-0.3	-0.3	-0.3	-1.0	-1.0
Random access	-0.2	-0.2	-0.3	-0.2	-0.7	-0.7
Low delay	-0.1	-0.2	-0.3	0.0	-0.4	-0.2

Average encoding times (%)

	High Efficiency	Low Complexity
Intra	101%	100%
Random access	99%	99%
Low delay	100%	100%

Average encoding times (%)

	High Efficiency	Low Complexity
Intra	101%	99%
Random access	95%	99%
Low delay	100%	100%

Results for LCU-level QP signaling (Median-only)

Average BD-Rates (%)

	High Efficiency			Low Complexity		
	Y	U	V	Y	U	V
Intra	0.0	0.0	0.0	0.0	0.0	0.0
Random access	0.1	0.0	0.1	0.2	0.0	0.0
Low delay	0.2	0.0	-0.3	0.4	0.2	0.4

Average encoding times (%)

	High Efficiency	Low Complexity
Intra	101%	99%
Random access	100%	100%
Low delay	100%	100%

Average encoding times (%)

	High Efficiency	Low Complexity
Intra	101%	100%
Random access	99%	102%
Low delay	100%	101%