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REDEFINING MOBILITY

H0554 non-CE1: Throughput improvement on CABAC coefficients level coding

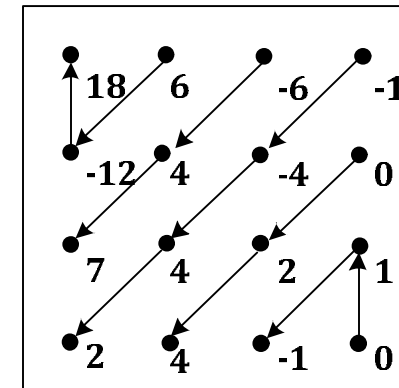Jianle Chen, Wei-Jung Chien, Joshi Rajan, Joel Sole, Marta Karczewicz

Background

- **Problem**
  - Entropy coding (CABAC) is bottleneck of the throughput, more problematic at low QP scenario

  - Three context coded bins for one coefficient
    - Significant_coeff_flag
    - Coeff_abs_level_greater1_flag
    - Coeff_abs_level_greater2_flag
    - Golomb-Rice code for remained level

  - Not all the context coded bins are beneficial for compression efficiency while exaggerating the throughput
    - Only code gr1Flag and gr2Flag for a few non-zero coefficients in a subset

Scan_pos	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Coefficients	0	1	-1	0	2	4	-1	-4	4	2	-6	4	7	6	-12	18
significantFlag	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
gr1Flag		0	0		1	1	0	1	1	1	1	1	1	1	1	1
gr2Flag					0	1		1	1	0	1	1	1	1	1	1
signFlag		0	1		0	0	1	1	0	0	1	0	0	0	1	0
levelRem						1		1	1		3	1	4	3	9	15

Proposed scheme (1/2)

- **Scheme 1**
  - Code *gr1Flag* until two coefficients with absolute level greater than 1 are encountered in a subset.
  - Code up to 1 *gr2Flag* a subset of 16 coefficients.

  - Early switch to Golomb-Rice by-pass code

Scan_pos	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Coefficients	0	1	-1	0	2	4	-1	-4	4	2	-6	4	7	6	-12	18
significantFlag	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
gr1Flag		0	0		1	1	0	1	1	1	1	1	1	1	1	1
gr2Flag					0	1		1	1	0	1	1	1	1	1	1
signFlag		0	1		0	0	1	1	0	0	1	0	0	0	1	0
levelRem						2	0	3	3	1	5	3	6	5	11	17

Proposed scheme   (2/2)

- ## Scheme 2

  - Code up to 8 *gr1Flag* for the non-zero coefficients in a subset of 16 coefficients.

  - Code up to 1 *gr2Flag* a subset of 16 coefficients.

  - Early switch to Golomb-Rice by-pass code

Scan_pos	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Coefficients	0	1	-1	0	2	4	-1	-4	4	2	-6	4	7	6	-12	18
significantFlag	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
gr1Flag		0	0		1	1	0	1	1	1	1	1	1	1	1	1
gr2Flag					0	1		1	1	0	1	1	1	1	1	1
signFlag		0	1		0	0	1	1	0	0	1	0	0	0	1	0
levelRem						2		2	2	0	4	3	6	5	11	17

Golomb-Rice parameter update table modification

- Update table right shift by 1 element

HM5.0 table

cLastRiceParam	Last coded remaining level															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	0	0	1	1	1	2	2	2	2	2	2	3	3	3	3	3
1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

New table

cLastRiceParam	Last coded remaining level															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	0	0	0	1	1	1	2	2	2	2	2	2	3	3	3	3
1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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Simulation Results (1/2)

- Scheme 1
- Test condition
  - Common test condition
  - Low QP test condition (1, 5, 9, 13)

Test configuration	*Scheme* I (Normal QP)			*Scheme* I (Low QP)		
	BD-rate					
	Y	Cb	Cr	Y	Cb	Cr
HE_Intra	-0.1%	-0.1%	-0.1%	-0.5%	-0.3%	-0.3%
HE_RA	-0.1%	-0.1%	-0.1%	0.0%	0.2%	0.2%
HE_LD	0.0%	0.1%	-0.1%	0.1%	0.3%	0.3%
LC_Intra	-0.1%	-0.1%	-0.1%	-0.5%	-0.3%	-0.3%
LC_RA	0.0%	0.1%	0.0%	0.0%	0.1%	0.1%
LC_LD	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%
HE_RA_10bits	0.1%	0.1%	0.1%	0.0%	0.4%	0.4%
Average	-0.04%	0.01%	-0.03%	-0.10%	0.08%	0.07%

Simulation Results (2/2)

- Scheme 2
- Test condition
    - Common test condition
    - Low QP test condition (1, 5, 9, 13)

Test configuration	Scheme II (Normal QP)			Scheme II (Low QP)		
	BD-rate					
	Y	Cb	Cr	Y	Cb	Cr
HE_Intra	-0.1%	-0.1%	-0.1%	-0.3%	-0.2%	-0.2%
HE_RA	0.0%	-0.1%	-0.2%	0.1%	0.2%	0.1%
HE_LD	0.0%	0.1%	-0.1%	0.1%	0.2%	0.2%
LC_Intra	-0.1%	-0.1%	-0.1%	-0.3%	-0.2%	-0.2%
LC_RA	0.0%	0.1%	-0.1%	0.0%	0.0%	0.0%
LC_LD	0.0%	0.1%	-0.3%	0.0%	0.1%	0.1%
HE_RA_10bits	0.1%	0.1%	0.2%	0.1%	0.3%	0.3%
Average	0.00%	0.02%	-0.06%	-0.05%	0.06%	0.03%

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Throughput data (1/3)

- **Amount of context coded bins**
  - Average number of context coded bins / pixel for all sequence at each QP
  - Maximum number of context coded bins / pixel in one picture within all sequence at each QP
    - HE, LC configuration: P and B pictures are considered

Throughput data (2/3)

- Scheme 1

Saving of max number of context coded bins / pixel in a picture for all sequence

QP	AI_HE	RA_HE	LB_HE	RA_10	AI_LC	RA_LC	LB_LC	Average
1	44%	41%	37%	40%	44%	40%	38%	41%
5	40%	36%	33%	34%	40%	34%	30%	35%
9	35%	28%	22%	23%	35%	26%	21%	27%
13	30%	22%	16%	12%	30%	21%	17%	21%
22	18%	13%	7%	3%	17%	10%	5%	10%
27	13%	5%	2%	18%	10%	4%	2%	8%
32	4%	2%	4%	5%	3%	-1%	1%	3%
37	5%	3%	1%	0%	4%	2%	-2%	2%

Saving of average number of context coded bins / pixel for all sequence

QP	AI_HE	RA_HE	LB_HE	RA_10	AI_LC	RA_LC	LB_LC	Average
1	37%	29%	29%	32%	36%	26%	26%	31%
5	30%	21%	21%	23%	30%	18%	18%	23%
9	25%	14%	14%	17%	23%	12%	11%	17%
13	20%	10%	8%	12%	19%	8%	6%	12%
22	14%	6%	4%	12%	11%	5%	2%	8%
27	10%	5%	3%	8%	8%	4%	2%	6%
32	6%	3%	2%	3%	5%	2%	1%	3%
37	3%	2%	1%	2%	2%	1%	1%	2%

Throughput data (3/3)

- Scheme 2

Saving of max number of context coded bins / pixel in a picture for all sequence

QP	AI_HE	RA_HE	LB_HE	RA_10	AI_LC	RA_LC	LB_LC	Average
1	36%	33%	31%	32%	35%	31%	28%	32%
5	32%	28%	25%	26%	32%	26%	21%	27%
9	28%	23%	17%	18%	27%	20%	15%	21%
13	24%	17%	13%	10%	23%	15%	14%	16%
22	15%	10%	6%	3%	13%	6%	3%	8%
27	9%	4%	1%	14%	8%	2%	2%	6%
32	4%	0%	0%	5%	2%	-1%	2%	2%
37	3%	3%	3%	0%	3%	1%	-7%	1%

Saving of average number of context coded bins / pixel for all sequence

QP	AI_HE	RA_HE	LB_HE	RA_10	AI_LC	RA_LC	LB_LC	Average
1	29%	22%	22%	24%	28%	18%	18%	23%
5	23%	16%	16%	18%	22%	12%	12%	17%
9	19%	11%	11%	13%	17%	9%	8%	13%
13	16%	7%	6%	9%	14%	5%	4%	9%
22	11%	5%	3%	9%	8%	3%	2%	6%
27	8%	4%	2%	6%	6%	2%	1%	4%
32	5%	2%	1%	3%	3%	1%	1%	2%
37	2%	1%	1%	2%	2%	1%	0%	1%

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- **Summary**
  - Simple change of current CABAC to restrict the number of context code *gr1flag* and *gr2flag* in a 16 coefficients subset, with worst case bin saving
    - Scheme 1: average 41% at QP 1, 10% at QP 22
    - Scheme 2: average 32% at QP 1, 8% at QP 22

  - Coding performance is slightly improved
    - Scheme 1: -0.04% (normal QP) and -0.10% (low QP) BD-rate gain
    - Scheme 2: -0.00% (normal QP) and -0.05% (low QP) BD-rate gain

  - Context models for *gr2Flag* syntax is reduced by 16

  - No additional calculation complexity is added

- **Recommendation**
  - Adoption of the proposed scheme 1 or scheme 2 in the next version of HM.

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■ Thanks

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