



Luma Intra Prediction Mode Coding

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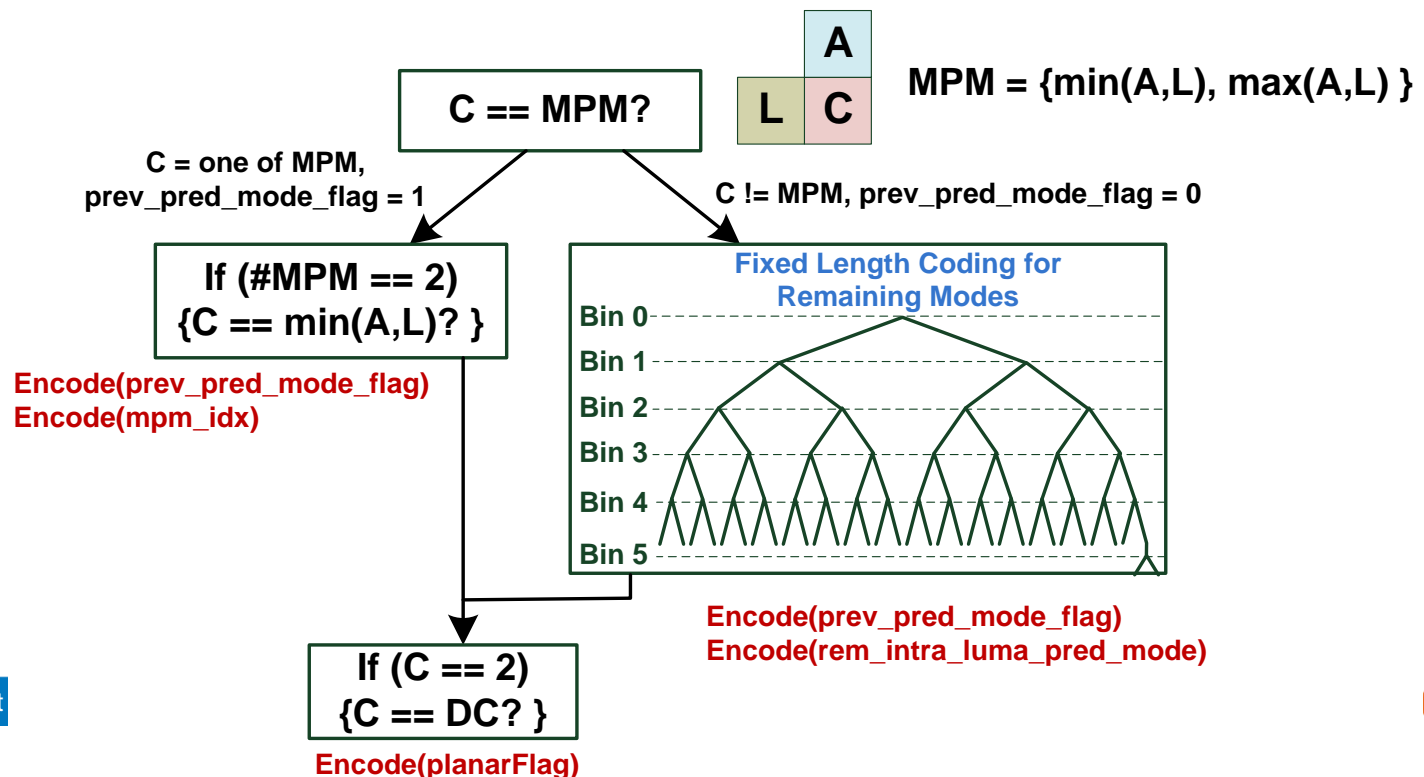
Overall Summary

- A two-level most probable mode (MPM) coding for luma intra prediction mode coding
 - 1st-level MPM coding : Mode A or Mode L (the same as HM3.0)
 - 2nd-level MPM coding : select at most 3 most probable remaining mode (MPRM) according to Mode A and Mode L
 - Remaining mode : fixed-length coding
- 0.4% of bit rate reduction with 1% encoding time increase

	All Intra HE		
	Y	U	V
Class A	-0.3	0.1	0.1
Class B	-0.3	0.0	0.1
Class C	-0.3	-0.1	-0.1
Class D	-0.3	-0.2	-0.1
Class E	-0.5	0.1	0.0
All	-0.4	0.0	0.0
Enc Time[%]	101%		
Dec Time[%]	100%		

CABAC Luma Intra Mode Coding in HM3.0

- One-level MPM coding
- 1 or 2 intra modes are selected as MPMs
 - Intra mode of above PU (Mode A) and left PU (Mode L)
- If current mode is not in MPMs, use fixed-length coding for remaining modes (rem_intra_luma_pred_mode)



Problem

- The probability distribution of remaining modes is not uniform
 - Different neighboring mode has different distribution
- The fixed length coding for remaining mode may not be suitable
- Select some modes with higher probability for 2-level MPM coding

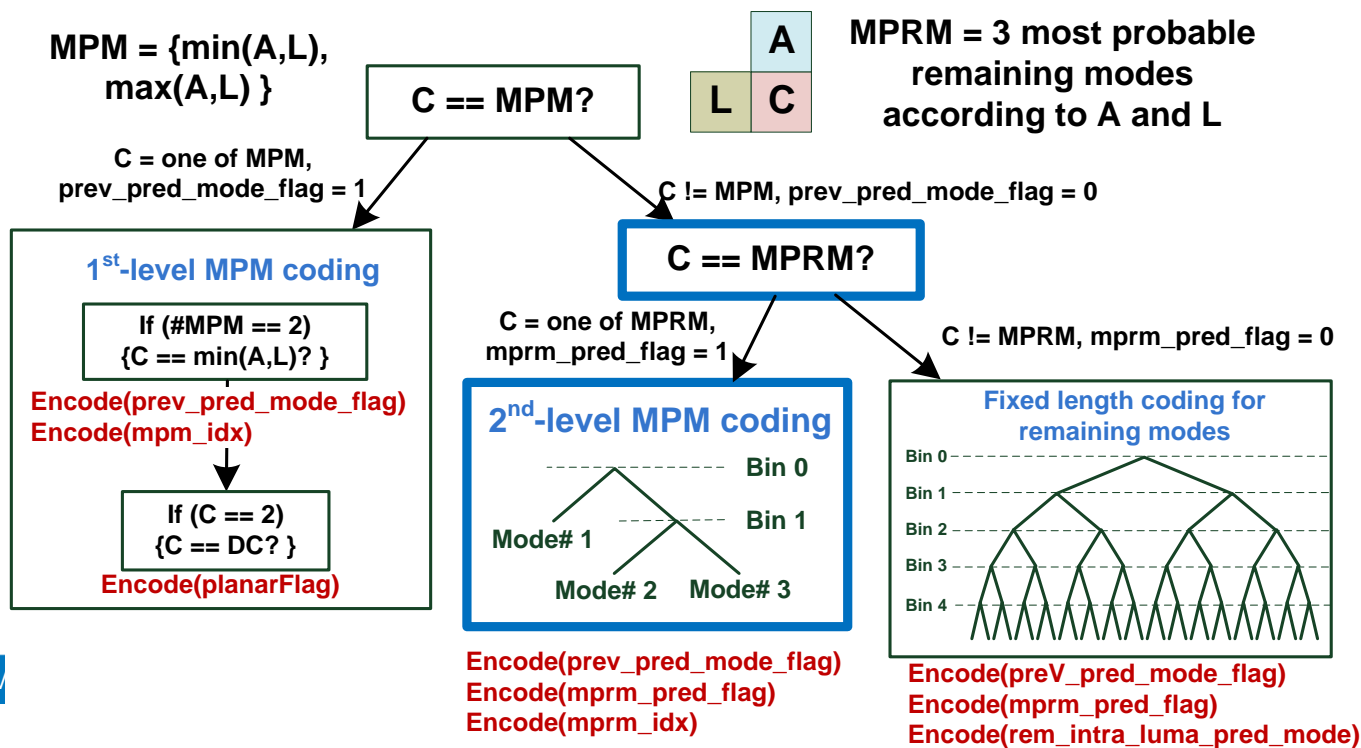
Remaining Mode

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
0		8.97%	3.25%	3.74%	3.51%	3.33%	2.34%	1.82%	2.21%	1.92%	2.22%	4.38%	3.39%	1.31%	1.29%	1.38%	1.72%	8.28%
1	8.32%		2.97%	3.44%	1.85%	1.65%	1.98%	2.87%	3.79%	2.45%	1.67%	1.57%	1.36%	1.01%	1.62%	3.72%	3.94%	7.92%
2	7.84%	6.46%		4.29%	2.90%	2.75%	2.55%	2.85%	3.46%	2.89%	2.36%	2.47%	2.07%	1.50%	1.87%	2.41%	2.67%	
3	7.32%	5.64%	4.46%		5.00%	2.49%	2.55%	4.48%	3.14%	2.79%	5.32%	2.74%	2.01%	1.35%	4.06%	2.55%	2.23%	8.74%
4	9.15%	4.45%	3.94%	6.10%		3.20%	2.48%	2.48%	2.54%	2.37%	5.37%	5.71%	2.96%	1.43%	2.22%	1.70%	1.74%	8.16%
5	9.09%	4.89%	4.22%	3.68%	3.48%		4.64%	2.40%	3.22%	3.90%	2.40%	3.53%	4.98%	3.63%	1.71%	1.97%	2.29%	9.81%
6	6.51%	6.38%	4.54%	3.98%	3.01%	4.29%		2.95%	5.78%	6.67%	2.39%	2.58%	2.49%	2.92%	1.99%	2.75%	3.57%	9.81%
7	5.20%	6.26%	4.07%	6.41%	2.83%	2.16%	2.16%		4.13%	2.94%	2.89%	2.00%	1.75%	1.37%	4.62%	5.11%	3.62%	8.36%
8	4.47%	4.76%	3.22%	2.78%	2.02%	2.10%	3.03%	2.53%		4.46%	1.63%	1.83%	1.98%	1.61%	1.65%	3.00%	5.80%	6.93%
9	8.64%	5.93%	4.94%	4.74%	3.75%	4.20%	5.21%	3.43%	5.54%		3.00%	3.24%	3.06%	2.75%	2.36%	3.10%	3.26%	10.11%
10	8.01%	5.16%	4.69%	9.15%	7.95%	3.01%	2.36%	3.50%	3.26%	3.30%		3.70%	2.39%	1.47%	3.68%	2.20%	2.06%	8.67%
11	11.21%	4.30%	3.92%	4.32%	6.45%	3.83%	2.54%	2.18%	2.90%	2.83%	3.02%		4.29%	1.75%	1.79%	1.82%	2.14%	8.18%
12	10.30%	4.08%	3.85%	3.51%	3.94%	6.48%	3.44%	2.14%	3.19%	3.40%	2.09%	5.00%		2.72%	1.66%	1.98%	2.34%	8.85%
13	6.32%	5.00%	4.68%	3.81%	3.10%	6.54%	6.01%	2.79%	5.06%	6.41%	2.00%	3.09%	3.68%		1.96%	2.73%	3.44%	9.82%
14	5.89%	5.43%	4.77%	9.57%	4.16%	2.58%	2.44%	7.29%	4.07%	3.49%	4.36%	2.73%	2.19%	1.73%		3.75%	3.10%	8.70%
15	4.75%	8.59%	3.88%	4.37%	2.28%	2.05%	2.28%	5.91%	5.63%	3.62%	1.98%	2.11%	1.93%	1.58%	3.00%		5.64%	8.15%
16	4.48%	7.24%	3.28%	2.95%	1.95%	1.99%	2.53%	3.16%	8.43%	4.02%	1.50%	2.00%	1.94%	1.62%	1.89%	4.71%		7.56%

Neighboring Mode

Proposed Two-level MPM Coding

- 1st-level : the same as the MPM coding in HM 3.0
- 2nd-level : select at most 3 MPRMs according to Mode A and Mode L
- Remaining mode : fixed-length coding
- Code DC and planar modes as different modes in 2nd-level MPM coding and remaining mode coding



MPRM Selection

- Predefine a 34x3 MPRM table and a 17x3 MPRM table
- $\text{MPRM}_{\text{init}} = \{A_1, L_1, A_2, L_2, A_3, L_3\}$
 - $\{A_1, A_2, A_3\}$ from Mode A
 - $\{L_1, L_2, L_3\}$ from Mode L
- Remove the modes equal to Mode A and Mode L, and take first 3 non-repetitive modes as $\text{MPRM} = \{M_1, M_2, M_3\}$

	MPRM		
Mode	1st Mode	2nd Mode	3rd Mode
0	Planar	1	11
1	Planar	0	16
2	0	1	
3	Planar	0	10
4	Planar	0	3
5	Planar	0	6
6	Planar	9	0
7	Planar	3	14
8	Planar	16	9
9	Planar	0	6
10	Planar	3	0
11	Planar	0	4
12	Planar	0	5
13	Planar	9	1
14	Planar	3	7
15	Planar	1	16
16	Planar	8	15

Simulation Results

- JCTVC-E700 anchor
- 0.4% bit rate reduction with 1% encoding time increase

	All Intra HE		
	Y	U	V
Class A	-0.3	0.1	0.1
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All	-0.4	0.0	0.0
Enc Time[%]	101%		
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Cross Verification

- We thank LG Electronics for crosschecking our proposal
 - JCTVC-F108
- BD-rates and run times are confirmed

Conclusions

- Proposed a two-level most probable mode (MPM) coding for luma intra prediction mode coding
 - 1st-level MPM coding : the same as HM 3.0
 - 2nd-level MPM coding : select at most 3 most probable remaining modes
 - Remaining mode : fixed-length coding
- 0.4% bit rate reduction with 1% encoding time increase
- Qualcomm and MediaTek have another joint proposal which adopts the two-level MPM coding