JCTVC-B042

Improvement of intra coding by Bidirectional Intra Prediction and 1 Dimensional Directional Unified Transform

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Summary

- **Intra coding tools**
  - Intra prediction
    - BIP (Bidirectional Intra prediction)
  - Intra transform
    - 1DDUT (1 Dimensional Directional Unified Transform)

- **Experimental results**
  - BIP
    - I-only: average of 3.72%   CS 1 : average of 2.06%
  - 1DDUT
    - I-only: average of 5.64%   CS 1 : average of 2.35%
  - BIP+1DDUT
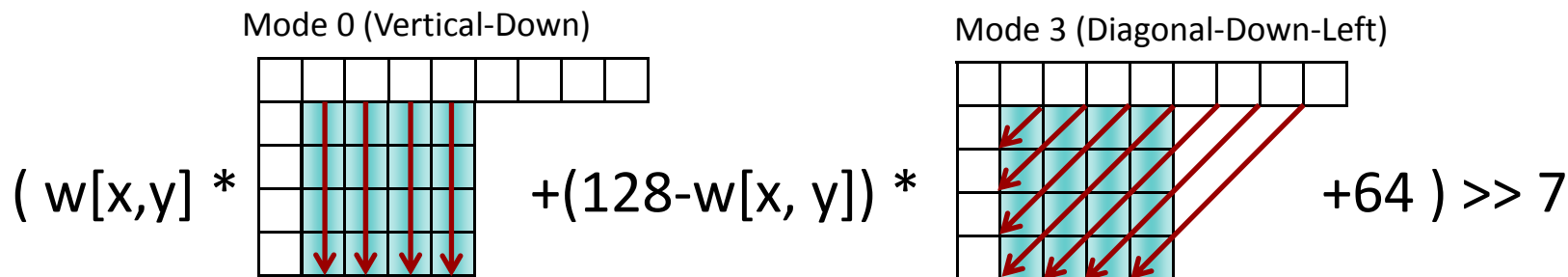   - I-only: average of 8.76%   CS 1 : average of 4.16%

Bi-directional Intra Prediction (BIP)

- **Coding efficiency improvement tool for intra coding**

  - Originally proposed at Marrakech VCEG meeting (VCEG-AE14)

  - Detailed specification is shown at Geneva VCEG meeting (C181)

  - KTA software is provided at ShenZhen VCEG meeting (VCEG-AG08)

- **BIP has two technical schemes.**

  - Weighted Bidirectional Prediction (WBP)

  - Adaptive Sub-block Coding Order (ASCO)
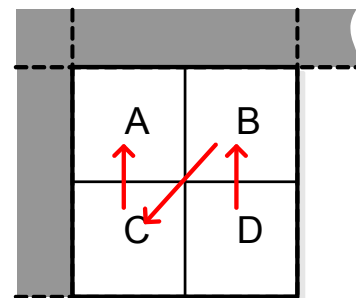
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Bi-directional Intra Prediction (BIP)

- **Weighted Bi-directional Prediction (4x4/8x8/16x16)**

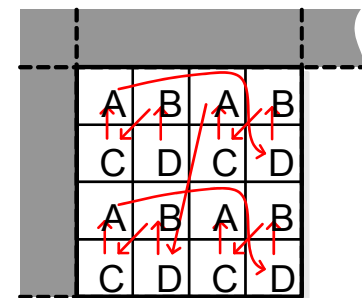 – Weighted average of two kinds of uni-directional prediction

  Mode 0 (Vertical-Down)   Mode 3 (Diagonal-Down-Left)

  $$(\, w[x,y] \, * \quad\quad +(128-w[x, y]) \, * \quad\quad +64 \,) >> 7$$

- **Adaptive Sub-block Coding Order**

  – Select sub-block coding order in the prediction unit

    - Raster order or Reverse order

  – Reverse order

    - Intra_8x8 : "D→B→C→A"

    - Intra_4x4 : "D→B→C→A→D→…"
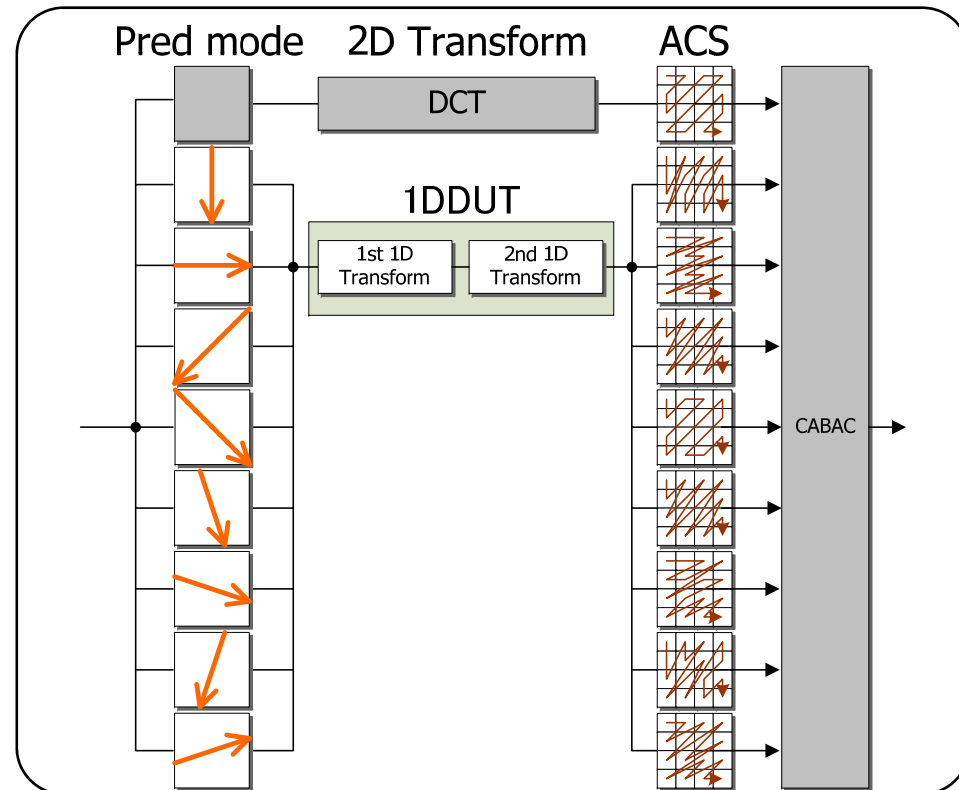
  (a) Sub-block size = 8x8

  (b) Sub-block size = 4x4

1 Dimensional Directional Unified Transform (1DDUT)

- **4/8/16-point 1 Dimensional Directional Unified Transform**
  - Additional two 1D transform matrices (Type A and B) compared with AVC
  - Pre-determined directional transform matrices based on KLT
  - Selecting three combinations of 1D transform matrices (AB, BA, BB) each prediction mode
- **Adaptive Coding Scan (ACS)**
  - Adaptive 2D-1D scan each prediction mode (same as MDDT)

Prediction Mode	1st 1D Transform	2nd 1D Transform
0	B	A
1	A	B
2	DCT	DCT
3	B	A
4	B	B
5	B	B
6	B	B
7	B	A
8	A	B

Experimental Conditions

- JM11.0KTA2.6r1 (BIP and 1DDUT are additionally implemented into SW)
- Test conditions are following on the Transform AHG's one basically.
- All CfP test sequences, the # of frames is about 2 seconds (not all 121).
- QP values are QPI=(27, 30, 34, 38); QPP=QPI+1; QPB=QPI+2.
- The following KTA tools are turned on; MVC, HPF, ExtMB and QALF

Class	Sequence	StartFrame	# of Coding Frames	
			Hierarchical B (CS1)	I-only
A	Traffic	0	65	65
	People on Street	0	65	65
B1	Kimono	0	49	49
	ParkScene	0	49	49
B2	Cactus	0	97	97
	BasketballDrive	0	97	97
	BQTerrace	0	129	129
C	BasketballDrill	0	97	97
	BQMall	0	129	129
	PartyScene	0	97	97
	RaceHorses	0	65	65
D	BasketballPass	0	97	97
	BQSquare	0	129	129
	BlowingBubbles	0	97	97
	RaceHorses	0	65	65
E	Vidyo1	0	N/A	129
	Vidyo3	0	N/A	129
	Vidyo4	0	N/A	129

Experimental results of I-only and CS1

Categories	Sequences	I-only structure			Hierarchical B structure (CS1)		
		BIP	1DDUT	BIP+1DDUT	BIP	1DDUT	BIP+1DDUT
		ΔBitrate (%)	ΔBitrate (%)	ΔBitrate (%)	ΔBitrate (%)	ΔBitrate (%)	ΔBitrate (%)
Class A	PeopleOnStreet	3.03	6.63	9.26	1.33	2.59	3.13
	Traffic	3.86	5.55	9.12	3.42	3.22	6.28
Class B	BQTerrace	4.64	6.29	10.15	2.46	2.78	5.16
	BasketballDrive	5.90	7.40	12.14	2.63	3.80	6.06
	Cactus	3.44	5.36	8.37	2.38	2.71	4.73
	Kimono1	5.78	8.26	13.08	2.04	3.02	4.81
	ParkScene	4.91	4.34	9.25	3.42	2.44	5.81
Class C	BQMall	3.91	5.50	8.66	2.08	1.77	3.37
	BasketballDrill	3.14	5.46	7.97	2.45	2.65	4.92
	PartyScene	2.99	3.58	5.86	1.73	1.66	3.17
	RaceHorses	2.23	3.45	5.36	1.06	1.47	2.40
Class D	BQSquare	2.77	4.55	6.49	1.46	1.98	2.90
	BasketballPass	3.95	4.30	8.04	2.20	2.03	4.06
	BlowingBubbles	3.22	3.88	6.56	1.23	1.50	2.69
	RaceHorses	2.89	4.25	6.56	1.09	1.62	2.83
Class E	vidyo1	3.06	7.54	9.76	N/A		
	vidyo3	3.01	8.06	10.62			
	vidyo4	4.26	7.09	10.39			
Class A Average		3.45	6.09	9.19	2.38	2.90	4.71
Class B Average		4.93	6.33	10.60	2.59	2.95	5.32
Class C Average		3.07	4.50	6.96	1.83	1.89	3.46
Class D Average		3.21	4.24	6.91	1.50	1.78	3.12
Class E Average		3.44	7.56	10.26	N/A		
Total Average		3.72	5.64	8.76	2.06	2.35	4.16

Conclusion

- **Two intra coding techniques**
  - Bidirectional Intra Prediction (BIP)
    - Weighted bidirectional prediction and adaptive sub-block coding order
  - 1 Dimensional Directional Unified Transform (1DDUT)
    - Only two additional 1D directional transform matrices

- **Experimental results of BIP, 1DDUT, and these combination are reported**
  - For I-only case, the average BD-rate gain of 3.72% for BIP, 5.64% for 1DDUT and 8.76% for the combination
  - For CS1 case, the average BD-rate gain of 2.06% for BIP, 2.35% for 1DDUT and 4.16% for the combination
  - These tools could achieve **promising gain** and these have **small overlap** in terms of coding efficiency