



Bi-Intra Prediction using slope information

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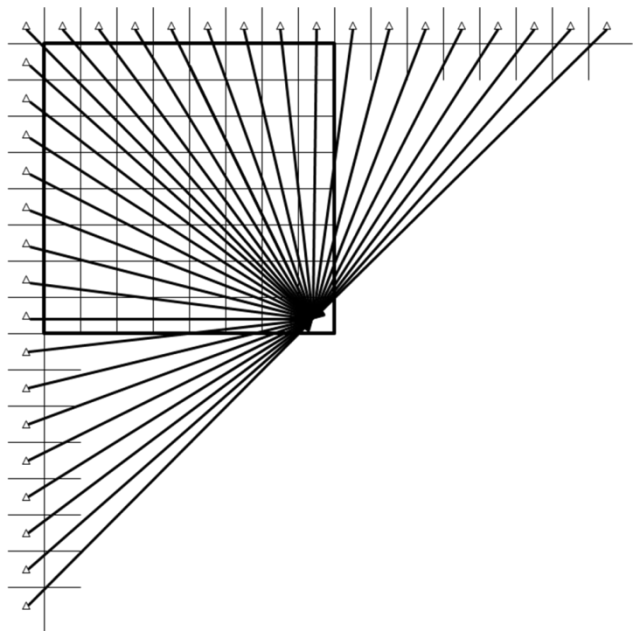


- Introduction
- Bi-Intra Prediction (BIP)
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Introduction



■ Unified Intra Prediction (UIP)



PU size	# of pred. directions
64x64	5
32x32	34
16x16	34
8x8	34
4x4	17

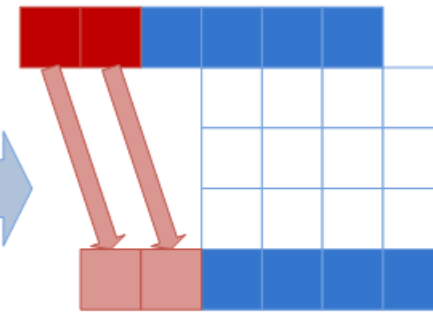
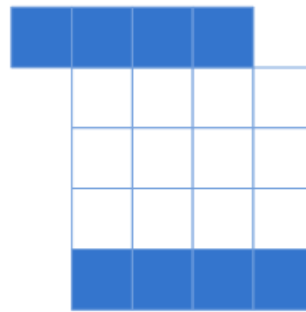
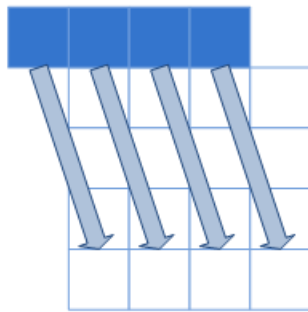
Available prediction directions in UIP

Bi-Intra Prediction (BIP) [1/4]

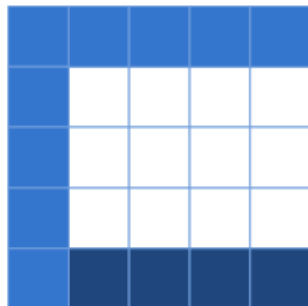
■ Algorithm of Bi-Intra Prediction

Ex) 4x4 Vertical prediction with a negative direction

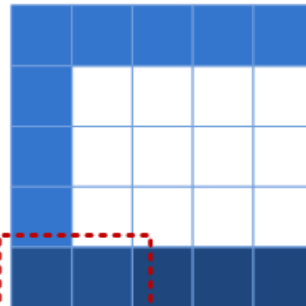
All prediction directions are used for BIP except for DC mode.



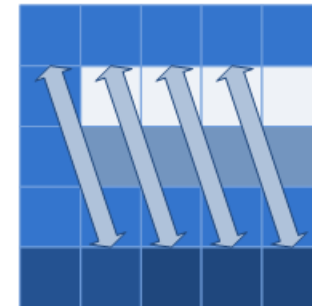
Compute an offset to predict the last line



Add the offset to the prediction values of the last line



Smoothing for the two reference pixels



Apply BIP

Bi-Intra Prediction (BIP) [2/4]

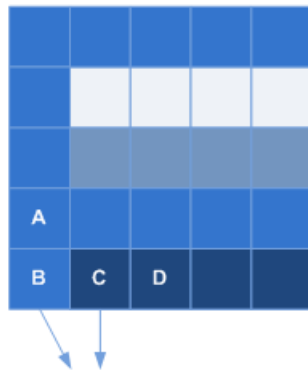


- The offset is not effective when the absolute value of that is too small.
- Threshold value for effective offset
 - Threshold = $2 \ll B_{inc}$
 - B_{inc} : # of bit depth increase
 - If (Threshold > |Offset|)
 - Offset = 0
- Clipping for large offset
 - Offset = Clip($-10 \ll B_{inc}$, $10 \ll B_{inc}$, Offset)
- Template size to calculate the offset
 - Block_size/2

Bi-Intra Prediction (BIP) [3/4]

- Reference pixel smoothing

Reference pixel smoothing



Smoothing filter

$$B' = (A + 2*B + C) / 4$$

$$C' = (B + 2*C + D) / 4$$

Performance of prediction would be degraded when the difference between B and C is large.

Bi-Intra Prediction (BIP) [4/4]



- The flag for BIP is embedded within the quantized transform coefficients.
 - Uni-intra prediction using UIP
 - Sum of absolute values of quantized coefficients is even. (0, 2, 4...)
 - Bi-intra prediction using offset and reference smoothing
 - Sum of absolute values of quantized coefficients is odd. (1, 3, 5...)
 - Uni- or bi-prediction is selected based on R-D optimization.

Simulations [1/4]



■ Simulation conditions

- Intra only / Random Access / Low delay
 - Low complexity
 - High Efficiency
- Test sequences
 - Class A (2560x1600)
 - Class B (1920x1080)
 - Class C (832x480)
 - Class D (416x240)
 - Class E (1280x720)
- Test Conditions
 - Common conditions defined by JCTVC-C500
- Anchor
 - HM-0.9

Simulations [2/4]



■ Summary

➤ Intra only

	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-1.0	-1.4	-1.6	-2.8	-2.3	-2.2
Class B	-0.6	-0.5	-0.6	-2.2	-1.8	-1.7
Class C	-0.6	-0.8	-0.8	-2.2	-1.9	-1.9
Class D	-0.7	-1.1	-1.1	-2.3	-1.8	-1.8
Class E	-0.6	-1.1	-1.0	-2.9	-2.4	-2.4
All	-0.6	-0.9	-0.9	-2.4	-2.0	-1.9
Enc Time[%]	150%			155%		
Dec Time[%]	101%			106%		

➤ Random access

	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.5	-0.7	-0.8	-1.0	-0.8	-0.8
Class B	-0.3	-0.4	-0.6	-0.8	-0.9	-0.8
Class C	-0.4	-0.6	-0.7	-0.8	-0.7	-0.7
Class D	-0.3	-0.5	-0.8	-0.8	-0.7	-0.7
Class E						
All	-0.3	-0.5	-0.7	-0.8	-0.8	-0.8
Enc Time[%]	104%			103%		
Dec Time[%]	100%			101%		

Simulations [3/4]



■ Summary [cont.]

➤ Low delay

	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	-0.1	-0.3	0.0	-0.2	-0.4	-0.2
Class C	-0.1	-0.3	-0.3	-0.2	-0.4	-0.2
Class D	0.0	-0.5	-0.2	-0.2	-0.1	-0.1
Class E	0.0	0.4	0.4	0.0	-0.4	0.0
All	-0.1	-0.2	0.0	-0.2	-0.3	-0.1
Enc Time[%]	104%			103%		
Dec Time[%]	100%			100%		

Simulations [4/4]



■ Performance for each sequence – Intra only

High Efficiency

Class	Sequence	BD-rate Y	BD-rate U	BD-rate V
A	Traffic	-0.98	-1.24	-1.38
	PeopleOnStreet	-1.00	-1.47	-1.80
B	Kimono	-0.23	-0.42	-0.46
	ParkScene	-0.58	-0.69	-0.76
	Cactus	-0.62	-0.52	-0.59
	BasketballDrive	-0.77	-0.64	-0.71
	BQTerrace	-0.67	-0.31	-0.50
C	BasketballDrill	-0.46	-0.20	-0.33
	BQMall	-0.63	-1.06	-1.13
	PartyScene	-0.63	-1.10	-1.08
	RaceHorses	-0.53	-0.71	-0.76
D	BasketballPass	-0.69	-1.07	-1.05
	BQSquare	-0.48	-0.82	-0.67
	BlowingBubbles	-0.79	-1.23	-1.28
	RaceHorses	-0.70	-1.11	-1.22
E	Vidyo1	-1.23	-1.81	-1.63
	Vidyo3	0.11	-0.62	-0.35
	Vidyo4	-0.71	-1.02	-1.01
Average		-0.64	-0.89	-0.93

Low Complexity

Class	Sequence	BD-rate Y	BD-rate U	BD-rate V
A	Traffic	-2.70	-2.33	-2.14
	PeopleOnStreet	-2.90	-2.26	-2.24
B	Kimono	-1.23	-1.27	-1.30
	ParkScene	-2.44	-2.00	-1.85
	Cactus	-2.54	-1.93	-1.71
	BasketballDrive	-2.61	-2.14	-2.10
	BQTerrace	-2.00	-1.56	-1.40
C	BasketballDrill	-2.06	-1.96	-2.01
	BQMall	-2.52	-2.12	-2.14
	PartyScene	-2.10	-1.56	-1.50
	RaceHorses	-2.31	-1.79	-1.78
D	BasketballPass	-2.41	-2.06	-2.22
	BQSquare	-1.91	-1.12	-1.15
	BlowingBubbles	-2.39	-1.94	-1.80
	RaceHorses	-2.60	-2.10	-2.15
E	Vidyo1	-3.62	-3.41	-3.35
	Vidyo3	-2.36	-1.76	-1.69
	Vidyo4	-2.72	-2.12	-2.08
Average		-2.41	-1.97	-1.92

Conclusions



- **BIP improves coding efficiency of intra prediction in HM.**
- **Encoding complexity could be handled using fast mode decision algorithms.**
- **BIP can be combined with any directional intra prediction method.**
 - Bidirectional intra prediction, DCIM, etc.
- **We suggest to study BIP in a CE.**