

JCTVC-E154

CE1: Report of DMVD-based Bi-prediction

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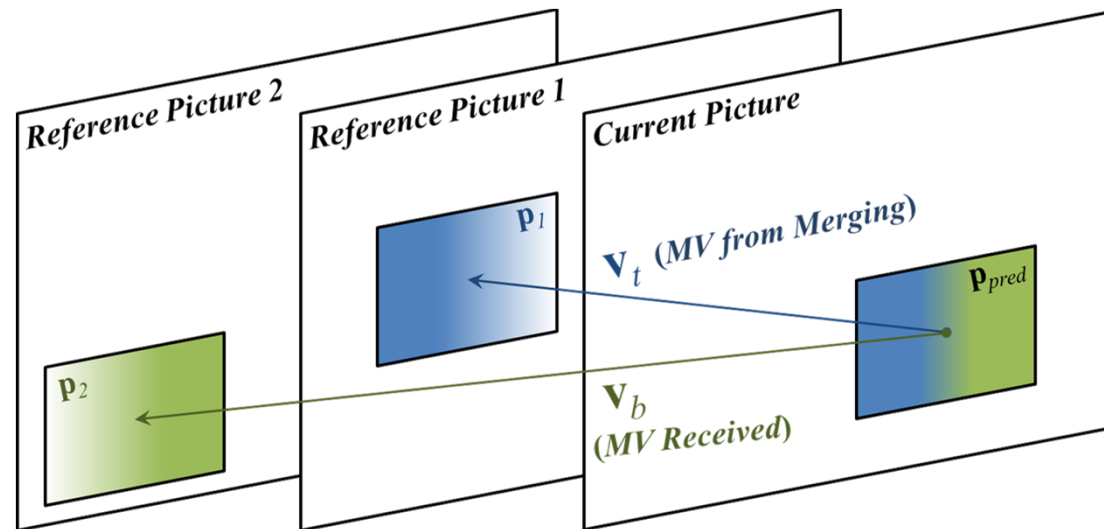
Summary

- Bi-prediction based on merged & block MVs (B072, D175)
 - An adaptive OBMC scheme for combining predictors
 - A modified block matching criterion for optimizing OBMC
- Two tests conducted
 - Test #1: 1 set of window functions
 - Test #2: 2 sets of window functions
- Results
 - Rate Saving : -1.6% (#1), -1.9% (#2)
 - Dec. Time : 104% (#1), 106% (#2)
 - Enc. Time : 153% (#1), 194% (#2)
 - Crosschecked by JVC KENWOOD (E213) & TUB (E232)

Technique

- Form a bi-prediction for a $2N \times 2N$ PU based on the merged and block MVs by OBMC

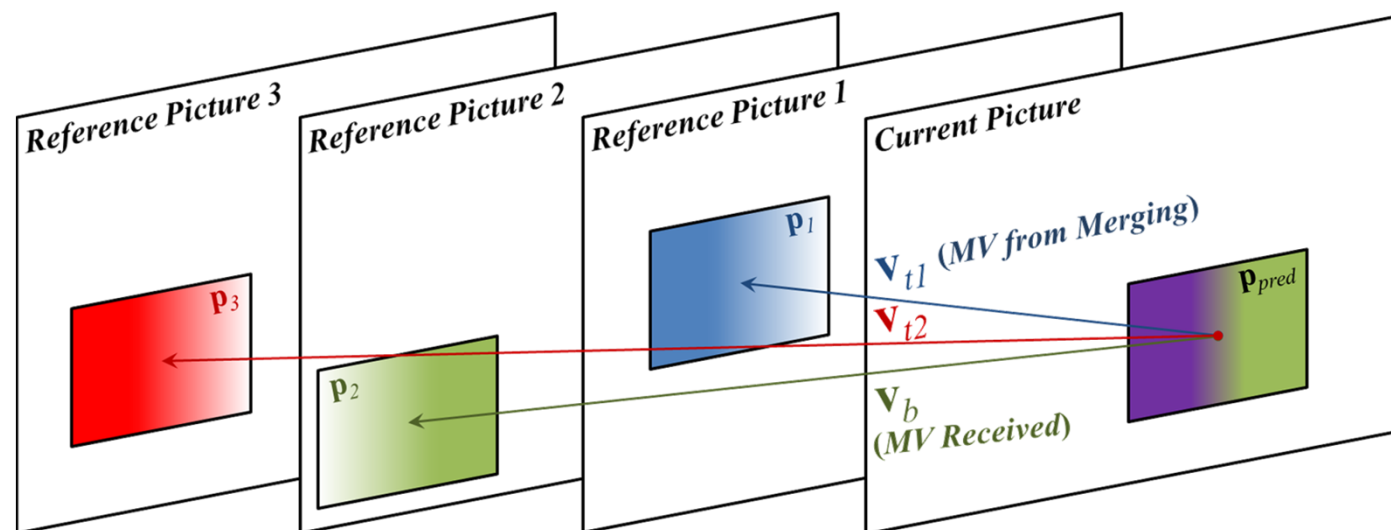
$$\mathbf{p}_{pred}(i, j; \mathbf{v}_t, \mathbf{v}_b) = \left\lfloor \mathbf{w}(i, j) \mathbf{p}_1(i, j; \mathbf{v}_t) + (1 - \mathbf{w}(i, j)) \mathbf{p}_2(i, j; \mathbf{v}_b) + 0.5 \right\rfloor$$



Extension

- Up to three hypotheses are used if the merged motion parameters are for bi-prediction

$$\mathbf{p}_{pred}(i, j; \{\mathbf{v}_t\}, \mathbf{v}_b) = \left\lfloor \underbrace{\mathbf{w}(i, j) \mathbf{r}(i, j)}_{\mathbf{r}(i, j) = \left(\underline{\mathbf{p}_1(i, j; \mathbf{v}_{t1})} + \underline{\mathbf{p}_3(i, j; \mathbf{v}_{t2})} + 1 \right) \gg 1} + (1 - \mathbf{w}(i, j)) \underline{\mathbf{p}_2(i, j; \mathbf{v}_b)} + 0.5 \right\rfloor$$



Selection of OBMC Windows

$w_{6,l}$: Above-left

7	7	7	7	7	4	4	1
7	7	7	7	4	4	1	1
7	7	7	4	4	1	1	1
7	7	4	4	1	1	1	1
7	4	4	1	1	1	1	1
4	4	1	1	1	1	1	1
4	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1

$w_{1,l}$: Left

6	4	4	1	1	1	1	1
6	4	4	1	1	1	1	1
6	4	4	1	1	1	1	1
6	4	4	1	1	1	1	1
6	4	4	1	1	1	1	1
6	4	4	1	1	1	1	1
6	4	4	1	1	1	1	1
6	4	4	1	1	1	1	1

$w_{5,l}$: Bottom-left

1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1
4	4	1	1	1	1	1	1
7	4	4	1	1	1	1	1
7	7	4	4	1	1	1	1
7	7	7	4	4	1	1	1
7	7	7	7	4	4	1	1
7	7	7	7	7	4	4	1

$w_{2,l}$: Above

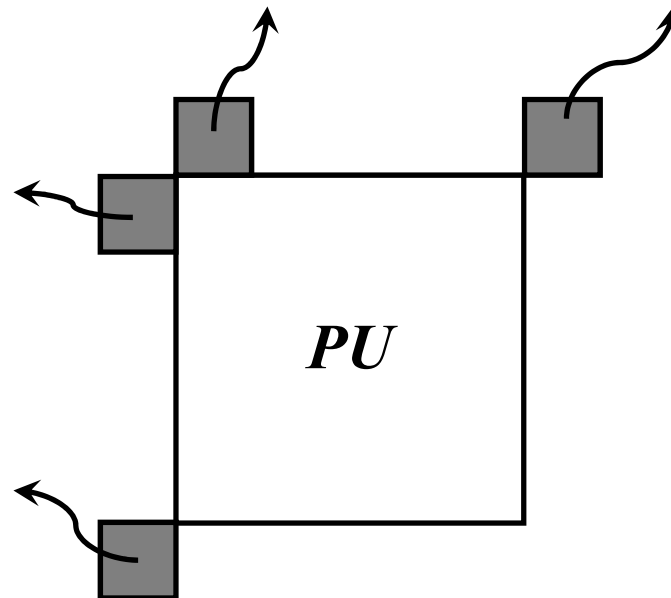
6	6	6	6	6	6	6	6
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1

$w_{4,l}$: Above-right

1	4	4	7	7	7	7	7
1	1	4	4	7	7	7	7
1	1	1	4	4	7	7	7
1	1	1	1	4	4	7	7
1	1	1	1	1	4	4	7
1	1	1	1	1	1	4	4
1	1	1	1	1	1	1	4
1	1	1	1	1	1	1	1

$w_{3,l}$: Co-located

4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4



Another Set for Test #2

$w_{6,2}$: Above-left

7	7	7	7	7	7	4	4
7	7	7	7	7	4	4	1
7	7	7	7	4	4	1	1
7	7	7	4	4	1	1	1
7	7	4	4	1	1	1	1
7	4	4	1	1	1	1	1
4	4	1	1	1	1	1	1
4	1	1	1	1	1	1	1

$w_{1,2}$: Left

6	6	6	4	4	1	1	1
6	6	6	4	4	1	1	1
6	6	6	4	4	1	1	1
6	6	6	4	4	1	1	1
6	6	6	4	4	1	1	1
6	6	6	4	4	1	1	1
6	6	6	4	4	1	1	1
6	6	6	4	4	1	1	1

$w_{5,2}$: Bottom-left

4	1	1	1	1	1	1	1
4	4	1	1	1	1	1	1
7	4	4	1	1	1	1	1
7	7	4	4	1	1	1	1
7	7	7	4	4	1	1	1
7	7	7	7	4	4	1	1
7	7	7	7	7	4	4	1
7	7	7	7	7	7	4	4

$w_{2,2}$: Above

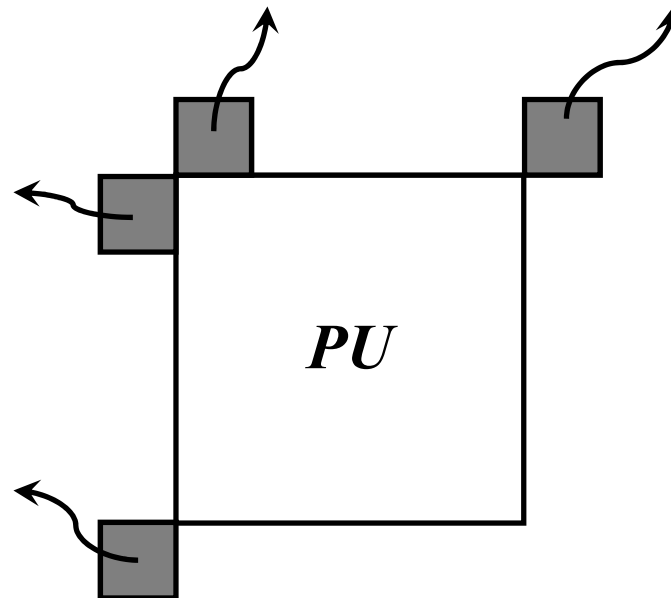
6	6	6	6	6	6	6	6
6	6	6	6	6	6	6	6
6	6	6	6	6	6	6	6
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1

$w_{4,2}$: Above-right

4	4	7	7	7	7	7	7
1	4	4	7	7	7	7	7
1	1	4	4	7	7	7	7
1	1	1	4	4	7	7	7
1	1	1	1	4	4	7	7
1	1	1	1	1	4	4	7
1	1	1	1	1	1	4	4
1	1	1	1	1	1	1	4

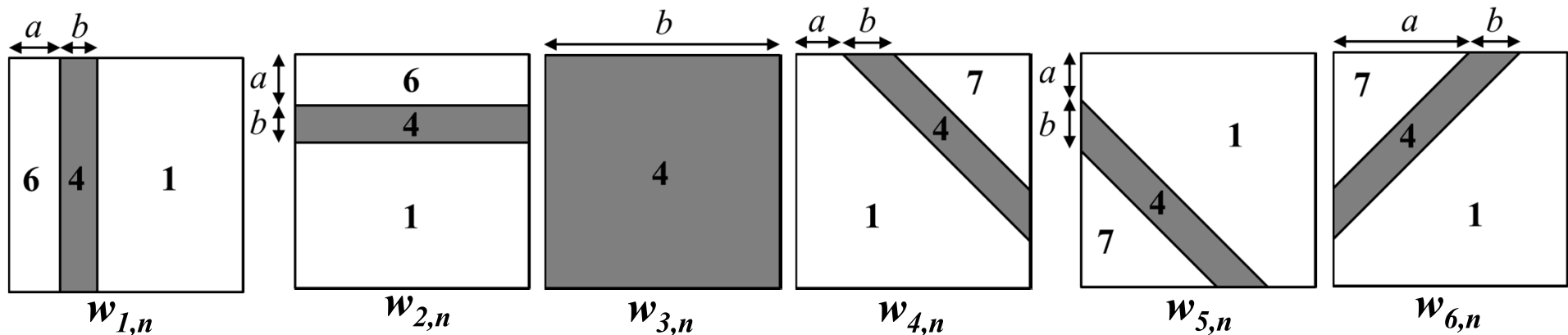
$w_{3,2}$: Co-located

4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4



Resizing Window Functions

- To match the size of the target $2N \times 2N$ PU
- Record the location where a transition in the value of the window function occurs
- Derive coefficients in the other regions by a prescribed mapping rule





Block Matching Criterion

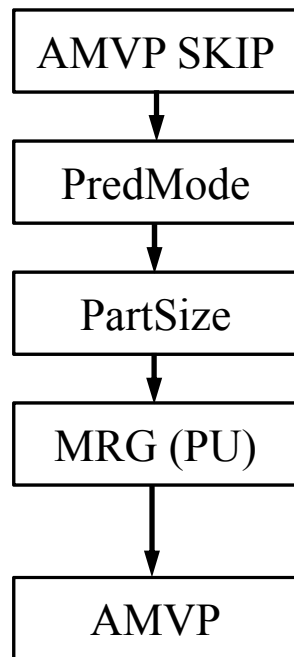
- Optimize MV for the current PU by considering the contribution from the merged ones

$$\mathbf{v}_b^* = \arg \min_{\mathbf{v}_b} \sum_{i=0}^{2N-1} \sum_{j=0}^{2N-1} \left| \mathbf{p}(i, j) - \mathbf{p}_{pred}(i, j; \{\mathbf{v}_t\}, \mathbf{v}_b) \right|$$

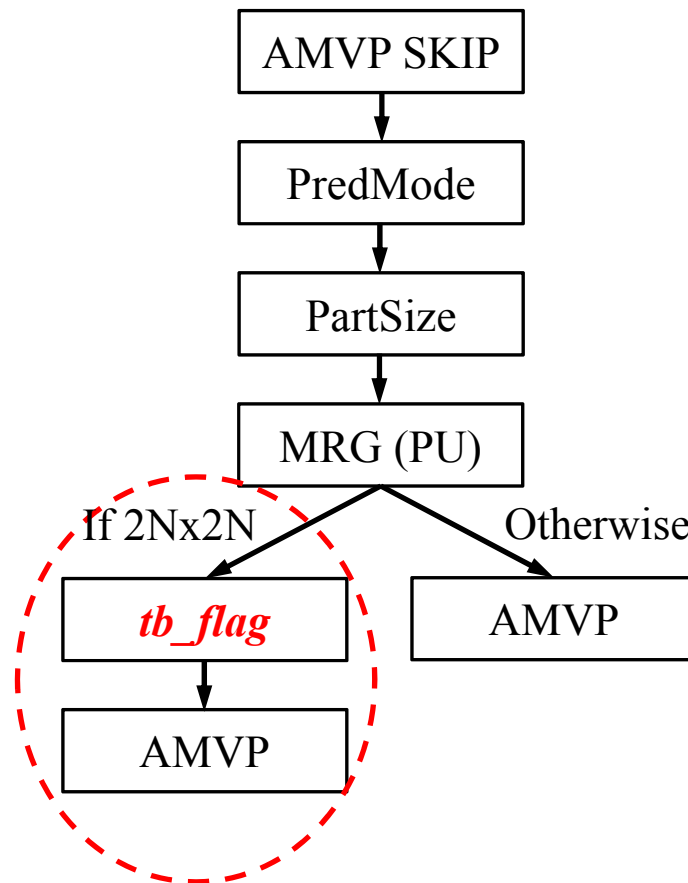
- An optimized \mathbf{v}_b^* has to be sought for each possible merge candidate $\{\mathbf{v}_t\}$

Syntax Modifications

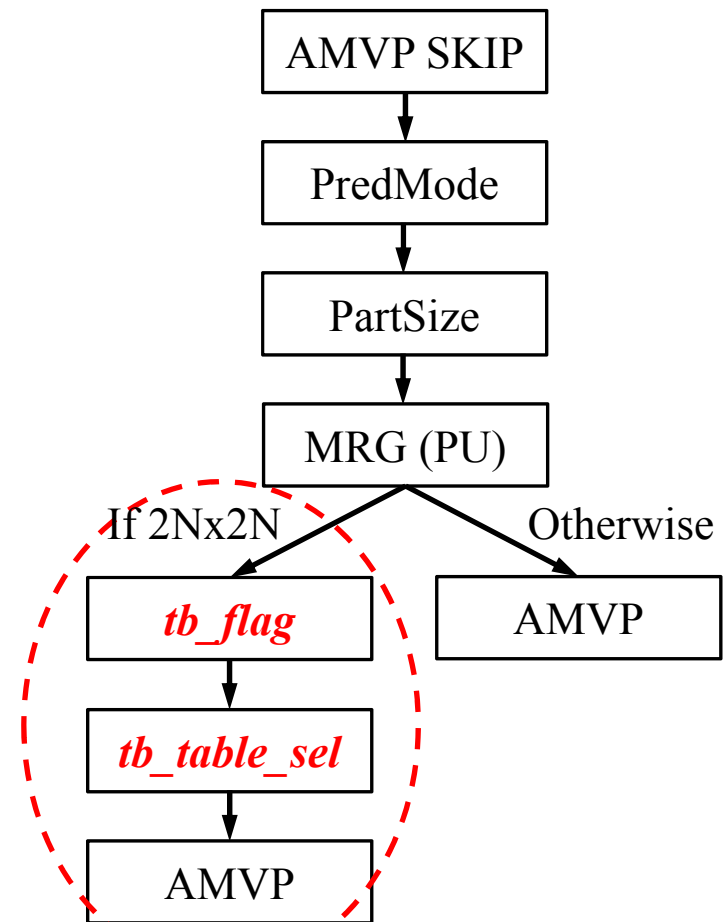
HM-2.0



Test #1



Test #2





Test #1

	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	-1.0	-1.5	-1.5	-1.4	-1.4	-1.2
Class B	-0.9	-1.3	-1.2	-1.1	-1.4	-1.4
Class C	-1.4	-1.9	-1.9	-1.5	-2.1	-2.2
Class D	-1.5	-2.1	-1.9	-1.6	-2.3	-2.2
Class E						
All	-1.2	-1.7	-1.6	-1.4	-1.8	-1.7
Enc Time[%]	162%			154%		
Dec Time[%]	103%			105%		
	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	-1.2	-2.1	-2.3	-2.0	-2.5	-2.0
Class C	-1.7	-2.2	-2.4	-2.3	-2.8	-2.9
Class D	-1.9	-1.8	-2.5	-2.3	-2.8	-2.4
Class E	-1.9	-3.1	-2.5	-2.6	-3.2	-2.8
All	-1.6	-2.2	-2.4	-2.3	-2.8	-2.5
Enc Time[%]	147%			151%		
Dec Time[%]	103%			106%		





Test #2

	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	-1.2	-1.8	-1.9	-1.5	-1.6	-1.3
Class B	-1.1	-1.5	-1.4	-1.3	-1.6	-1.6
Class C	-1.7	-2.2	-2.3	-1.8	-2.5	-2.6
Class D	-1.8	-2.1	-2.2	-1.9	-2.6	-2.5
Class E						
All	-1.4	-1.9	-1.9	-1.6	-2.0	-2.0
Enc Time[%]	202%			200%		
Dec Time[%]	105%			107%		
	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	-1.5	-2.4	-2.5	-2.4	-2.9	-2.4
Class C	-2.1	-2.5	-2.5	-2.6	-3.0	-3.2
Class D	-2.3	-2.5	-2.6	-2.7	-2.9	-2.5
Class E	-2.1	-3.6	-2.8	-3.0	-4.0	-3.4
All	-1.9	-2.7	-2.6	-2.6	-3.1	-2.8
Enc Time[%]	183%			194%		
Dec Time[%]	104%			109%		



Further Results on Test #2

	Random Access		Random Access LoCo	
	Y BD-rate (#2)	Y BD-rate (#2')	Y BD-rate (#2)	Y BD-rate (#2')
Class A	-1.2	-1.3	-1.5	-1.6
Class B	-1.1	-1.2	-1.3	-1.3
Class C	-1.7	-1.8	-1.8	-1.9
Class D	-1.8	-2.0	-1.9	-2.0
Class E				
All	-1.4	-1.6	-1.6	-1.7
Enc Time[%]	202%	207%	200%	199%
Dec Time[%]	105%	102%	107%	104%
	Low Delay		Low Delay LoCo	
	Y BD-rate (#2)	Y BD-rate (#2')	Y BD-rate (#2)	Y BD-rate (#2')
Class A				
Class B	-1.5	-1.8	-2.4	-2.4
Class C	-2.1	-2.2	-2.6	-2.7
Class D	-2.3	-2.5	-2.7	-2.9
Class E	-2.1	-2.5	-3.0	-3.2
All	-1.9	-2.2	-2.6	-2.8
Enc Time[%]	183%	179%	194%	188%
Dec Time[%]	104%	101%	109%	106%



Conclusions

- A bi-prediction scheme based on merged and block MVs was studied in this subtest
- The technique performs adaptive OBMC depending on how the merged motion parameters are derived
- It was observed to have moderate-to-significant gains, with a slight increase in decoding time and a moderate-to-significant increase in encoding time
- We thank JVC KENWOOD and TUB for crosschecking the results
- We recommend the JCT-VC committee consider adopting this technique into the HM software and the working draft or continuing its study in a CE