

JCTVC-D046

CE7: Mode-Dependent Transforms for Block- based Intra Coding

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Background

$$Y = C_m X R_m^T$$

$C_m, R_m \in \{M, K\}$

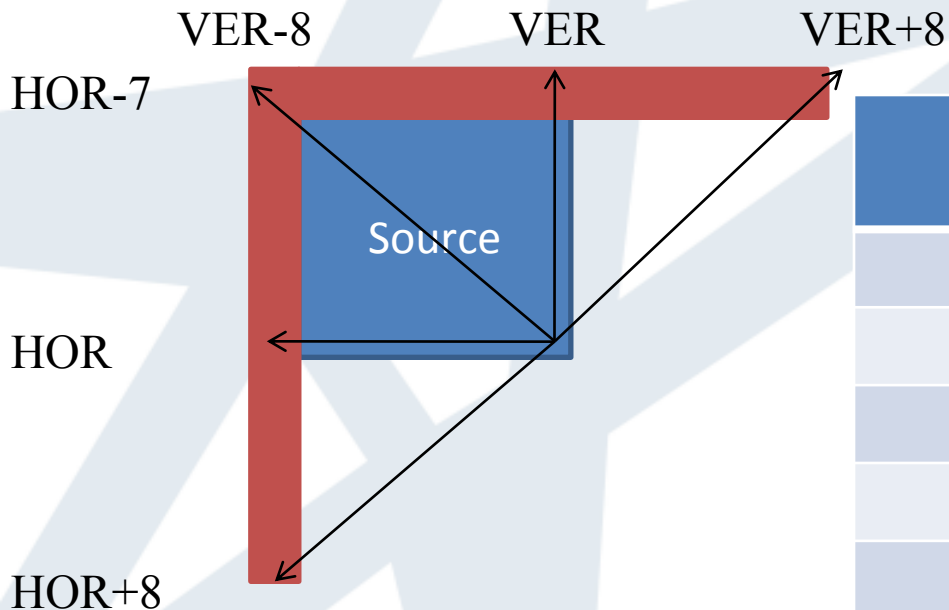
↗ Odd-Type DST-III
 $K_{i,j} = \frac{2}{\sqrt{2N+1}} \sin\left(\frac{(2i-1)j\pi}{2N+1}\right)$

↘ DCT

Trained KLTs	Proposal
Requires training to compute KLT	No training required
Needs 18 transforms to be implemented	Needs only 2 transforms
16 muls, 12 adds per 4-pt tx	8 muls, 10 adds per 4-pt tx <i>6 shifts, 15 adds per 4-pt tx (D048, D286)</i>
All modes use KLT	Combination of DCT/DST

Combination of DCT/DST

- Choice based on which reference pixels are used for prediction



Mode	Column Tx	Row Tx
DC	EDCT2	EDCT2
VER-8 to VER-1	ODST3	ODST3
VER to VER+8	ODST3	EDCT2
HOR-7 to HOR-1	ODST3	ODST3
HOR to HOR+8	EDCT2	ODST3

Experimental conditions

- Only difference from anchor is the use of DCT/DST for intra residual coding of 4x4 and 8x8
 - Fixed point arithmetic with 7 fractional bits
- Following JCTVC-C500 and JCTVC-C507
 - Test Intra (high-efficiency and low-complexity) and Random Access (high-efficiency and low-complexity)

Results (Proposed DCT/DST)

	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-2.2	-2.5	-2.6	-3.6	-1.5	-1.0
Class B	-0.9	-1.1	-1.1	-1.7	-1.1	-0.9
Class C	-1.2	-1.0	-1.0	-1.9	-1.1	-1.1
Class D	-1.3	-1.1	-1.0	-1.9	-1.0	-1.0
Class E	-1.5	-1.7	-1.5	-2.7	-0.4	-0.9
All	-1.3	-1.4	-1.3	-2.2	-1.0	-1.0
Enc Time[%]	101%			103%		
Dec Time[%]	101%			104%		

	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	-0.9	-0.5	-0.2	-1.2	-0.2	0.1
Class B	-0.5	-0.3	-0.4	-0.6	-0.3	-0.3
Class C	-0.6	-0.3	-0.4	-0.6	-0.3	-0.3
Class D	-0.6	-0.3	-0.1	-0.5	-0.2	-0.2
Class E						
All	-0.6	-0.3	-0.3	-0.7	-0.2	-0.2
Enc Time[%]	100%			100%		
Dec Time[%]	100%			101%		

Results (Trained KLTs)

	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-2.3	-2.4	-2.5	-3.5	-1.6	-1.2
Class B	-1.0	-1.2	-1.2	-1.9	-1.3	-1.1
Class C	-1.2	-1.1	-1.1	-2.0	-1.3	-1.3
Class D	-1.4	-1.2	-1.2	-2.0	-1.2	-1.2
Class E	-1.6	-1.7	-1.6	-2.9	-0.6	-1.1
All	-1.4	-1.4	-1.4	-2.3	-1.2	-1.1
Enc Time[%]	101%			105%		
Dec Time[%]	102%			106%		

	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	-0.4	-0.2	-1.3	-0.2	0.1
Class B	-0.6	-0.3	-0.3	-0.8	-0.3	-0.3
Class C	-0.7	-0.4	-0.5	-0.7	-0.4	-0.3
Class D	-0.7	-0.1	-0.2	-0.6	-0.3	-0.3
Class E						
All	-0.7	-0.3	-0.3	-0.8	-0.3	-0.2
Enc Time[%]	100%			100%		
Dec Time[%]	100%			101%		

Results (D048)

- 4-point DST uses a multiplier-less version with 6 shifts, 15 adds. 4-point DCT uses the HM DCT

	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-2.2	-2.4	-2.4	-3.0	-1.6	-1.2
Class B	-0.9	-1.1	-1.1	-1.5	-1.2	-1.0
Class C	-1.2	-1.0	-1.1	-1.8	-1.2	-1.2
Class D	-1.3	-1.0	-1.0	-1.8	-1.1	-1.1
Class E	-1.5	-1.8	-1.7	-2.5	-0.7	-1.1
All	-1.3	-1.3	-1.3	-2.0	-1.1	-1.1
Enc Time[%]	102%			105%		
Dec Time[%]	101%			104%		

	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	-0.9	-0.6	-0.3	-1.1	-0.2	-0.1
Class B	-0.5	-0.4	-0.5	-0.6	-0.3	-0.3
Class C	-0.7	-0.6	-0.6	-0.6	-0.5	-0.4
Class D	-0.6	-0.1	0.0	-0.5	-0.4	-0.2
Class E						
All	-0.6	-0.4	-0.4	-0.6	-0.4	-0.3
Enc Time[%]	101%			101%		
Dec Time[%]	100%			100%		

Complexity

- Operations count for DST
 - 4-point: 8 multiplies, 10 adds
 - 8-point: 64 multiplies, 56 adds
- Requires two transforms

Training

- No training required to derive transform matrix

Conclusions

- CE7 results for I²R's DCT/DST proposal
 - No significant difference in coding performance from trained KLTs
 - One additional transform, no training required
- Cross-checked by D104, D306, D353
- Recommend adoption into HM