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JCTVC-E428

Low Complexity Embedding of Information in Transform Coefficients

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Introduction

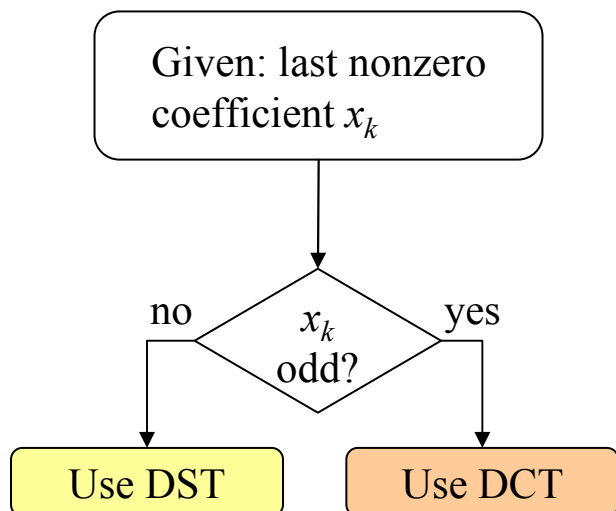
- In CE7: Alternative Transforms some proposals signaled which of several transforms to use in the bit stream.
- In prior work¹, embedding (data hiding) has been used to put information in quantized transform coefficients.
 - R-D optimization and other computations used to adjust coefficients
 - Adds to complexity vs. explicit signaling
- This contribution: Try extremely simple embedding scheme to convey transform selection
 - Since R-D optimization already being used to select transform:
 - Embed transform index in quantized transform coefficients
 - Use very simple scheme suitable for low-complexity configuration
 - Let the transform selection R-D process avoid high-distortion choices
 - Implemented in adaptive DCT/DST software from JCTVC-D182

¹[J-M. Thiesse, J. Jung, and M. Antonini, "Data hiding of Intra prediction information in chroma samples for video compression," ICIP 2010]

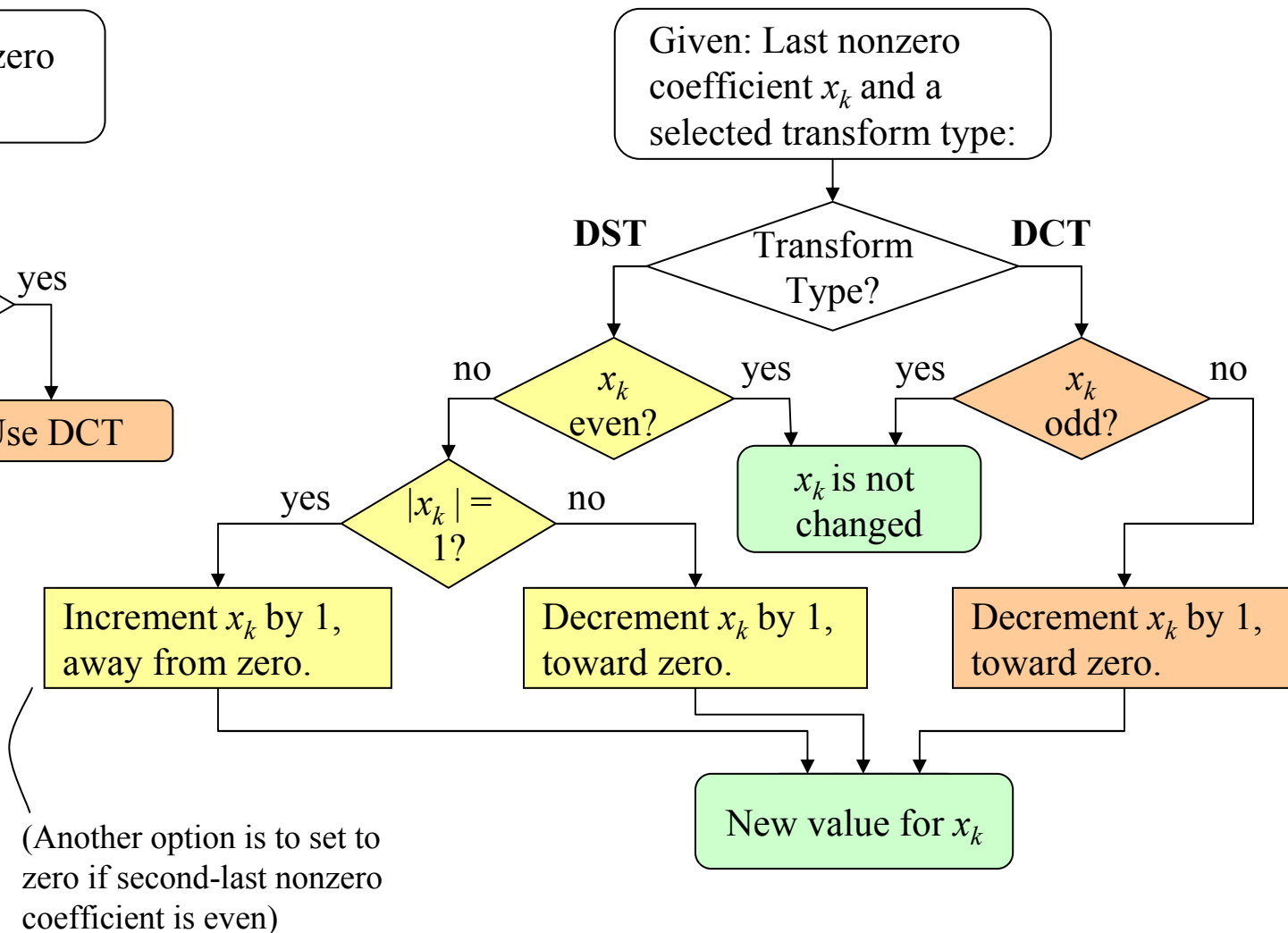


Embedding of Transform Type

Decoder



Encoder



Experimental Results

- Software: NHK's adaptive DCT/DST tool¹ (JCTVC-D182) modified to embed the DCT/DST selection flag
- Reference: HM 0.9, as the DCT/DST software was already available from the previous JCT-VC meeting
- Tested classes C & D using Intra LC configurations
- Applies to Luma only. Chroma PSNRs were identical to reference

¹MERL would like to thank NHK for the use of their software.



Performance for Class C sequences, I-LC

Class C 842x480	QP	HM 0.9		Explicitly Signalled		BD-rate			Embedded		BD-rate		
		kbps	Y psnr	kbps	Y psnr	Y	U	V	kbps	Y psnr	Y	U	V
S08 BasketballDrill	22	23538.94	41.38	23799.02	41.48				23448.57	41.34			
	27	12734.76	37.92	12879.69	37.98	0.4	1.2	1.4	12683.05	37.89	0.4	-0.5	-0.4
	32	6666.53	35.01	6763.75	35.03				6638.55	34.97			
	37	3566.04	32.48	3618.42	32.48				3549.72	32.44			
S09 BQMall	22	26950.83	41.73	27255.77	41.80				26875.00	41.69			
	27	16049.83	38.67	16254.03	38.73	0.6	1.2	1.2	15985.37	38.62	0.5	-0.5	-0.5
	32	9202.16	35.57	9348.31	35.60				9162.73	35.51			
	37	5154.20	32.58	5233.17	32.58				5122.49	32.52			
S10 PartyScene	22	48268.32	40.81	48528.96	40.99				48047.26	40.77			
	27	30107.20	36.56	30321.61	36.71	-1.0	0.9	0.9	29945.05	36.52	0.0	-0.6	-0.7
	32	17536.41	32.66	17750.17	32.81				17442.54	32.63			
	37	9292.26	29.09	9446.50	29.19				9241.76	29.05			
S11 RaceHorses	22	16864.75	42.05	16919.66	42.14				16780.62	42.02			
	27	10177.89	38.53	10208.89	38.61	-0.9	0.6	0.6	10110.32	38.50	-0.1	-0.7	-0.7
	32	5640.84	35.05	5687.50	35.15				5603.93	35.02			
	37	2738.02	31.81	2776.06	31.88				2721.59	31.78			

Negative BD-Rates indicate improvement



Performance for Class D sequences, I-LC

		HM 0.9		Explicitly Signalled		BD-rate			Embedded		BD-rate		
Class D 416x240	QP	kbps	Y psnr	kbps	Y psnr	Y	U	V	kbps	Y psnr	Y	U	V
S12 BasketballPass	22	6065.35	42.56	6129.70	42.62				6048.40	42.50			
	27	3583.33	38.92	3628.03	38.97	0.7	1.2	1.3	3569.21	38.87	0.5	-0.5	-0.5
	32	1987.61	35.53	2018.82	35.56				1980.14	35.48			
	37	1071.54	32.52	1087.64	32.52				1065.54	32.47			
S13 BQSquare	22	14457.87	40.97	14505.93	41.15				14376.74	40.93			
	27	9267.14	36.49	9320.49	36.65	-1.1	0.7	0.8	9214.51	36.45	-0.1	-0.8	-0.7
	32	5651.81	32.58	5706.06	32.73				5620.59	32.54			
	37	3317.35	29.07	3368.29	29.21				3298.66	29.04			
S14 BlowingBubbles	22	12731.62	40.73	12804.39	40.92				12677.60	40.69			
	27	7833.26	36.33	7908.23	36.48	-0.8	1.1	1.1	7796.81	36.29	0.0	-0.6	-0.5
	32	4350.87	32.36	4417.39	32.48				4331.60	32.33			
	37	2190.00	28.99	2225.79	29.05				2178.02	28.95			
S15 RaceHorses	22	5078.42	41.99	5090.39	42.08				5052.42	41.95			
	27	3033.55	37.86	3051.62	37.98	-0.7	0.7	0.8	3018.41	37.83	0.1	-0.5	-0.5
	32	1606.36	34.10	1626.55	34.20				1600.53	34.07			
	37	792.15	31.06	804.97	31.10				787.55	31.01			

Negative BD-Rates indicate improvement



Conclusions

- Explicit signaling of transform choice increases bit-rate and decreases distortion
- Embedding of transform choice decreases bit-rate and increases distortion
- Chroma unaffected: U,V BD-Rate metrics can be ignored
- Distortion is caused by adjusting coefficients; there were many cases where before adjusting, $x = [-1 \ 1 \ 0 \ 0 \ 0 \ \dots]$
- Some cases showed small improvements; further work needed
- Simple embedding schemes may be useful if surrounding optimization processes compensates for distortion

