

CE6-related: NSST with 8 Coefficients Computation

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- RST is recently adapted tool**

Test #	Description	Required Bytes	Multiplications per coefficient	Comment
CE6-3.1a	(4 transform sets. 2 transforms per set)	10240	16	<u>16 is not practical</u>
CE6-3.1b	(4 transform sets. 2 transforms per set) + (Secondary transform uses at most maximum 8 multiplications/sample)	10240	8	<u>Hight memory</u>
CE6-3.1c	(4 transform sets. 2 transforms per set) + (Secondary transform uses at most maximum 8 multiplications/sample) + (Secondary transform is disabled for 4x4 TU)	10240	8	<u>Not beneficial</u>
CE6-3.1d	(4 transform sets. 2 transforms per set) + (Secondary transform uses at most maximum 8 multiplications/sample) + (16x48 matrices are employed instead of 16x64 ones)	8192	8	<u>Adopted</u>
CE6-3.1e	(4 transform sets. 1 transforms per set)	5120	16	<u>16 is not practical</u>

Problem: High memory for compared to MST:

NSST: 8.2 KBytes for 1.3% gain w.r.t. MTS: 2.7 KBytes for 1.9% gain

In this contribution:

- Reduce memory/operations to half
- Simplify NSST flag coding by removing coefficients scanning

Test 1

- **Take CE6-3.1e as a reference (1Tr per set)**
 - Compute 8 RST coefficients for all block sizes
 - NSST flag is always coded, without checking the zero out coefficients value

	All Intra Main10					Random access Main10				
	Over VTM-4.0					Over VTM-4.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.73%	0.31%	0.66%	101%	99%	-0.39%	-0.75%	-0.78%	106%	100%
Class A2	-0.59%	0.93%	1.57%	102%	100%	-0.20%	-0.72%	-0.29%	104%	100%
Class B	-0.21%	0.75%	0.07%	100%	101%	-0.10%	-0.73%	-1.50%	105%	101%
Class C	-0.43%	0.32%	0.02%	99%	101%	-0.10%	-0.25%	-0.74%	104%	100%
Class E	-0.41%	0.11%	-0.85%	94%	101%					
Overall	-0.44%	0.50%	0.25%	99%	101%	-0.18%	-0.60%	-0.91%	105%	100%
Class D	-0.17%	0.53%	0.07%	100%	101%	0.00%	-0.29%	-0.83%	104%	99%
Class F	-0.58%	0.42%	0.19%	100%	101%	-0.24%	-0.29%	-0.34%	121%	107%

- ➔ Total memory: 2560 KBytes

- Take CE6-3.1e as a reference (1Tr per set)

- Compute 8 RST coefficients for all block sizes with width and height larger or equal to 8, or width and height equal to 4
- NSST flag is always coded, without checking the zero out coefficients value

	All Intra Main10					Random access Main10					Low delay B Main10				
	Over VTM-4.0					Over VTM-4.0					Over VTM-4.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.76%	0.36%	0.73%	102%	100%	-0.44%	-0.81%	-0.84%	106%	100%					
Class A2	-0.64%	0.93%	1.46%	103%	102%	-0.22%	-0.77%	-0.38%	103%	100%					
Class B	-0.29%	0.64%	-0.02%	101%	102%	-0.14%	-0.71%	-1.63%	103%	99%	-0.05%	-0.27%	-0.58%	104%	100%
Class C	-0.64%	0.23%	-0.15%	102%	102%	-0.20%	-0.25%	-0.62%	98%	85%	-0.07%	0.01%	-0.38%	104%	102%
Class E	-0.62%	0.11%	-0.76%	95%	101%						0.04%	0.89%	-0.97%	102%	102%
Overall	-0.56%	0.46%	0.20%	101%	102%	-0.23%	-0.62%	-0.95%	102%	95%	-0.03%	0.11%	-0.61%	104%	101%
Class D	-0.42%	0.38%	-0.20%	102%	103%	-0.12%	-0.74%	-1.07%	97%	88%	-0.05%	-0.22%	-0.73%	104%	102%
Class F	-0.74%	0.25%	0.03%	101%	103%	-0.32%	-0.29%	-0.26%	118%	102%	-0.32%	-0.32%	-0.58%	104%	101%

- ➔ Total memory: 3072 KBytes

Test 3

- **Take CE6-3.1D as a reference**

- Compute 8 RST coefficients for all block sizes with width and height larger or equal to 8
- NSST flag is always coded, without checking the zero out coefficients value

	All Intra Main10				
	Over VTM-4.0				
	Y	U	V	EncT	DecT
Class A1	-1.71%	-0.84%	-0.79%	123%	99%
Class A2	-0.98%	0.22%	0.64%	127%	100%
Class B	-0.71%	-0.09%	-1.09%	126%	100%
Class C	-0.98%	-0.16%	-0.80%	126%	101%
Class E	-1.21%	-1.19%	-1.94%	117%	101%
Overall	-1.06%	-0.36%	-0.83%	124%	100%
Class D	-0.64%	-0.21%	-0.82%	130%	100%
Class F	-1.03%	-0.03%	-0.21%	115%	103%

- ➔ Total memory: 5120 KBytes

- Take CE6-3.1B as a reference

- Compute 8 RST coefficients for all block sizes with width and height larger or equal to 8
- NSST flag is always coded, without checking the zero out coefficients value

	All Intra Main10 Over VTM-4.0				
	Y	U	V	EncT	DecT
Class A1	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!
Class A2	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!
Class B	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!
Class C	-1.08%	-0.34%	-1.01%	126%	102%
Class E	-1.27%	-1.25%	-2.19%	118%	102%
Overall	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!
Class D	-0.69%	-0.19%	-0.91%	129%	102%
Class F	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!

- ➔ Total memory: 6144 KBytes

Memory comparison

Test	No. Tr per Set	Total Memory (Byte)	AI Luma gain
CE6-3.1B	2	10240	1.4%
CE6-3.1D	2	8192	1.3%
Current proposal (Test1)	1	2560	0.4%
Current proposal (Test2)	1	3072	0.6%
Current proposal (Test3)	2	5120	1.1%
Current proposal (Test4)	2	6144	Xx%

- **A light weight RST is presented with:**
 - Half memory requirement
 - 8 coefficients are only computed, at least for large block sizes
 - Simple flag coding
 - 8 multiplication per coefficient (max)
 - Can achieve up to 1.1% luma gain in AI
- **Results encourages either:**
 - Direct adoption of 8 coefficients restriction
 - Study further improvement with new basis