

JCTVC-D339

Fast Integer Transforms for the HM

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Motivation

- Transforms in HM 0.9 have good features
 - Good compression efficiency
 - Reasonably low complexity
- But complexity can be reduced further
 - Single design, with mult or mult-free
 - No loss of performance
- FastVDO chaired AhG: Spatial Transforms
 - Also BoG Spatial Transforms

Part of D365 With Samsung

- This proposal is a part of D365 with Samsung
- Point of D339 is to clarify our perspective
 - Single mult / mult-free design
 - Very low complexity
 - High performance
- Suitable quantizers remains to be designed

Proposal

- 4-pt and 8-pt transforms untouched
 - In retrospect, these are suboptimal
- Focused on 16-pt, 32-pt
- Reuse of 16-pt in 32-pt
- Remark: 32-pt can be further reduced
 - Partial frequency
 - 16 x H2

Complexity 1

	16x16 Chen transform (now in HM 0.9)	16x16 New Integer transform	16x16 New Integer Transform +lifting	16x16 New Integer Transform +lifting +Mult-free	32x32 Chen transform (now in HM 0.9)	32x32 New integer transform	32x32 New integer +lifting	32x32 New integer +lifting +Mult-free
Mults	1408	1344	768	0	7424	6656	4224	0
Adds	2368	2304	2496	3776	12416	11904	12928	22976
Shift	832	768	864	2784	4224	3712	4480	17152
Total	4608	4416	4128	6560	24064	22272	21632	40128

Complexity

	16x16 matrix mult	16x16 Chen Transf.	16x16 Loeffler Transf.	16-pt Mult- Free Transf.	32x32 matrix mult.	32x32 Chen Transf.	32x32 Loeffler Transf.	32-pt Mult- free Transf.
Mults	4096	1408	1344	0	32768	7424	6656	0
Adds	3840	2368	2304	3776	31774	12416	11904	22976
Shifts	0	832	768	2784	0	4224	3712	17152
Total	7936	4608	4416	6560	64542	24064	22272	40128

Performance 1

Table 9. Performance of new integer transforms + lifting

	Intra			Intra LoCo		
	Y <u>BD-rate</u>	U <u>BD-rate</u>	V <u>BD-rate</u>	Y <u>BD-rate</u>	U <u>BD-rate</u>	V <u>BD-rate</u>
Class A	-0.04	-0.05	-0.08	0.04	0.01	0.02
Class B	-0.02	0.00	0.02	0.02	-0.01	-0.01
Class C	0.00	0.01	0.00	0.00	0.01	0.02
Class D	0.00	0.01	-0.02	0.00	0.01	-0.02
Class E	-0.05	-0.01	-0.13	0.02	0.04	0.07
All	-0.02	0.00	-0.03	0.01	0.01	0.01
Enc Time[%]	103%			98%		
Dec Time[%]	103%			98%		

	Random access			Random access LoCo		
	Y <u>BD-rate</u>	U <u>BD-rate</u>	V <u>BD-rate</u>	Y <u>BD-rate</u>	U <u>BD-rate</u>	V <u>BD-rate</u>
Class A	-0.02	0.08	0.22	-0.01	0.05	0.01
Class B	-0.01	0.07	0.05	-0.01	-0.01	0.04
Class C	-0.02	-0.02	-0.02	0.00	-0.09	-0.01
Class D	0.00	0.13	0.09	0.00	-0.23	0.07
Class E						
All	-0.01	0.06	0.06	0.00	-0.08	0.03
Enc Time[%]	102%			101%		
Dec Time[%]	102%			101%		

Performance 2

	Low delay			Low delay LoCo		
	<u>Y BD-rate</u>	<u>U BD-rate</u>	<u>V BD-rate</u>	<u>Y BD-rate</u>	<u>U BD-rate</u>	<u>V BD-rate</u>
Class A						
Class B	0.00	-0.11	-0.21	0.03	-0.09	-0.12
Class C	0.01	0.09	-0.11	0.06	-0.16	0.06
Class D	0.03	-0.28	0.22	-0.03	0.25	-0.14
Class E	-0.20	0.10	-0.49	0.04	-0.06	0.03
All	-0.02	-0.06	-0.13	0.02	-0.01	-0.05
Enc Time[%]	98%			99%		
Dec Time[%]	97%			98%		

Performance

- As promised, effectively identical to HM
 - More details presented in D365
 - Complexity essentially minimal
 - No mults; adds/shifts effectively minimal
 - 4-pt, 8-pt can also be integrated into paradigm
 - Slight gains may be possible

Conclusion

- Excellent performance available
 - Significant reduction in complexity
 - Mults can be eliminated completely
 - Full-dimensional complexity analysis pending
 - Several good solutions available
 - Best are based on Loeffler's factorization in our view
- Recommend a CE on Core Transforms
 - Explore performance / complexity tradeoffs
 - Fixed (small) set of complexity metrics
 - Samsung/FastVDO have released SW to group