JCTVC-E083

Evaluation and Suggestions About TU Representation in HEVC

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Outline

- Introduction
- Part 1: Evaluation about current RQT structure
- Part 2: Proposed encoder complexity reduction
- Part 3: Proposed TU representation
- Experimental results
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Introduction

- RQT (Residual Quad Tree) defined TU size
  - Max: 32x32
  - Min: 4x4
  - Constrained by CU
  - But not by PU
  - Parameter set in the SPS:

log2_min_transform_block_size_minus2	ue(v)
log2_diff_max_min_transform_block_size	ue(v)
max_transform_hierarchy_depth_inter	ue(v)
max_transform_hierarchy_depth_intra	ue(v)

RQT in HM2.0

Current RQT max depth configurations

	HE	LC
Inter	3	2
Intra	3	1

High Efficiency

CU	PU	TU	
64x64	64x64	32x32, 16x16, 8x8	
	64x32	32x32, 16x16, 8x8	
	32x64	32x32, 16x16, 8x8	
32x32	32x32	32x32, 16x16, 8x8	
	32x16	32x32, 16x16, 8x8	
	16x32	32x32, 16x16, 8x8	
16x16	16x16	16x16, 8x8, 4x4	
	16x8	16x16, 8x8, 4x4	
	8x16	16x16, 8x8, 4x4	
8x8	8x8	8x8, 4x4	
	8x4	8x8, 4x4	
	4x8	8x8, 4x4	
	4x4	8x8	4x4

Low Complexity

CU	PU	TU	
64x64	64x64	32x32	16x16
	64x32	32x32	16x16
	32x64	32x32	16x16
32x32	32x32	32x32	16x16
	32x16	32x32	16x16
	16x32	32x32	16x16
16x16	16x16	16x16	8x8
	16x8	16x16	8x8
	8x16	16x16	8x8
8x8	8x8	8x8	4x4
	8x4	8x8	4x4
	4x8	8x8	4x4
	4x4	8x8	4x4

Part 1: Evaluation About Current RQT Depth

- Anchor HM 2.0
- Common test conditions D600
- Cases
  - HE max Inter depth = 2, max Intra depth = 2
  - HE max Inter depth = 1, max Intra depth = 1
  - LC max Inter depth = 1, max Intra depth = 1

Evaluation Result (1)

- Max RQT depth Inter=2, Intra=2, compared with anchor (HE)

	Intra		
	Y BD-rate	U BD-rate	V BD-rate
Class A	0.1	0.1	0.1
Class B	0.2	0.2	0.2
Class C	0.1	0.1	0.1
Class D	0.1	0.1	0.1
Class E	0.2	0.1	0.1
All	0.1	0.1	0.1
Enc Time[%]	95%		
Dec Time[%]	100%		

	Random access		
	Y BD-rate	U BD-rate	V BD-rate
Class A	0.3	0.2	-0.2
Class B	0.4	0.4	0.4
Class C	0.3	0.2	0.2
Class D	0.3	-0.1	0.1
Class E			
All	0.3	0.2	0.1
Enc Time[%]	90%		
Dec Time[%]	100%		

	Low delay		
	Y BD-rate	U BD-rate	V BD-rate
Class A			
Class B	0.4	1.0	0.9
Class C	0.3	0.8	0.7
Class D	0.3	0.9	0.3
Class E	0.1	-0.9	0.9
All	0.3	0.6	0.7
Enc Time[%]	92%		
Dec Time[%]	100%		

Evaluation Result (2)

- Max RQT depth Inter=1, Intra=1, compared with anchor (HE, LC)

	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	0.2	0.2	0.1			
Class B	0.5	0.4	0.4			
Class C	0.5	0.4	0.4			
Class D	0.4	0.3	0.3			
Class E	0.5	0.2	0.4			
All	0.4	0.3	0.3			
Enc Time[%]	91%					
Dec Time[%]	100%					

	Random access mtk			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	1.1	0.5	-0.1	1.2	0.7	0.7
Class B	1.5	0.6	0.4	1.5	-0.7	-0.9
Class C	1.8	0.4	0.4	2.0	-0.7	-0.8
Class D	2.7	0.6	0.7	3.2	-1.1	-0.9
Class E						
All	1.7	0.5	0.4	1.9	-0.5	-0.5
Enc Time[%]	80%			95%		
Dec Time[%]	100%			100%		

	Low delay mtk			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	0	0	0	0	0	0
Class B	1.8	1.4	1.2	2.3	-1.5	-1.4
Class C	2.6	0.9	1.0	3.3	-1.0	-1.6
Class D	3.7	1.7	0.9	4.9	-1.7	-1.7
Class E	0.8	-1.1	1.3	1.4	-2.3	-1.6
All	2.3	0.9	1.1	3.0	-1.6	-1.6
Enc Time[%]	83%			96%		
Dec Time[%]	100%			101%		

Part 2: Encoder Complexity Reduction

- In HM2.0 RDO
  - CU 2Nx2N (full CU) merge, RD-cost for every merge candidate is fully calculated (i.e. encoded, including transform) in order to decide the best merge candidate (merge index)
  - CU Nx2N or 2NxN (partial) merge, fast estimation is used to decide the merge index; actual RD-cost (from full encoding) is only calculated once for the selected merge candidate

- Proposal
  - Apply the fast estimation method that has been included in HM2.0 for partial CU merge to full (2Nx2N) CU merge in RDO.

Result for Encoder Complexity Reduction

	Random access mtk		
	Y BD-rate	U BD-rate	V BD-rate
Class A	0.2	0.2	0.2
Class B	0.3	0.3	0.2
Class C	0.2	0.2	0.3
Class D	0.1	0.0	0.1
Class E			
All	0.2	0.2	0.2
Enc Time[%]	93%		
Dec Time[%]	100%		

	Low delay		
	Y BD-rate	U BD-rate	V BD-rate
Class A			
Class B	0.7	0.1	-0.1
Class C	0.4	0.3	0.3
Class D	0.3	0.4	-0.4
Class E	0.3	-0.4	0.6
All	0.4	0.1	0.1
Enc Time[%]	94%		
Dec Time[%]	100%		

Part 3: Proposed TU Representation – 1

- Relate TU size to not only CU but also PU

  max_TU_width_height = min(PU_width, PU_height)

  min_TU_width_height = CU_width_height / 2

- As a result for a 2Nx2N CU
  - If partition type is 2Nx2N, one bit "split_transform_flag".
  - If partition type is Nx2N, 2NxN or NxN, no "split_transform_flag" needed, NxN TU inferred.

transform_unit(x0, y0, log2TrafoSize, trafoDepth, blkIdx) {	**Descriptor**
...	
if (residualDataPresentFlag) {	
split_transform_flag = 1	
if(trafoDepth==0 && PartMode==PART_2Nx2N) {	
split_transform_flag	u(1) | ae(v)
...	
}	
...	
}	
}	

Result – 1

	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	0.1	0.1	0.1	0.1	1.1	1.1
Class B	0.2	0.2	0.2	-0.2	0.7	0.8
Class C	0.1	0.1	0.1	-0.2	0.3	0.4
Class D	0.1	0.1	0.1	-0.1	0.3	0.2
Class E	0.2	0.1	0.1	-0.2	2.2	1.8
All	0.1	0.1	0.1	-0.1	0.9	0.8
Enc Time[%]	95%					
Dec Time[%]	100%					

	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	0.3	0.3	0.1	0.0	1.5	1.3
Class B	0.4	0.3	0.3	0.0	1.1	1.1
Class C	0.4	0.3	0.3	0.0	0.5	0.7
Class D	0.4	0.1	0.2	0.0	0.5	0.5
Class E						
All	0.4	0.2	0.2	0.0	0.9	0.9
Enc Time[%]	89%					
Dec Time[%]	100%					

	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	0.5	1.2	1.4	0.2	0.9	1.2
Class C	0.5	0.9	0.8	0.1	0.7	0.8
Class D	0.4	1.0	0.7	0.2	0.6	1.3
Class E	0.4	0.6	1.1	0.2	3.2	1.9
All	0.5	0.9	1.0	0.2	1.2	1.3
Enc Time[%]	91%					
Dec Time[%]	100%					

Part 3: Proposed TU Representation – 2

- Relate TU size to not only CU but also PU

  max_TU_width_height = max(PU_width, PU_height)

  min_TU_width_height = CU_width_height / 2

- As a result for a 2Nx2N CU
  - If partition type is 2Nx2N, Nx2N or 2NxN, "split_transform_flag".
  - If partition type is NxN, no "split_transform_flag" needed, NxN TU inferred.

transform_unit(x0, y0, log2TrafoSize, trafoDepth, blkIdx) {	**Descriptor**
...	
if (residualDataPresentFlag) {	
split_transform_flag = 1	
if(trafoDepth==0 && PartMode!=PART_NxN) {	
split_transform_flag	u(1) | ae(v)
...	
}	
...	
}	
}	

Result – 2

	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	0.1	0.1	0.1	0.1	1.1	1.1
Class B	0.2	0.2	0.2	-0.2	0.7	0.8
Class C	0.1	0.1	0.1	-0.2	0.3	0.4
Class D	0.1	0.1	0.1	-0.1	0.3	0.2
Class E	0.2	0.1	0.1	-0.2	2.2	1.8
All	0.1	0.1	0.1	-0.1	0.9	0.8
Enc Time[%]	95%					
Dec Time[%]	100%					

	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	0.2	0.2	-0.2	0.1	1.5	1.4
Class B	0.3	0.3	0.2	-0.1	0.9	0.9
Class C	0.3	0.2	0.2	-0.1	0.3	0.4
Class D	0.3	-0.1	0.2	-0.1	0.2	0.4
Class E						
All	0.3	0.2	0.1	0.0	0.7	0.8
Enc Time[%]	92%					
Dec Time[%]	100%					

	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	0.3	0.8	0.9	-0.1	0.5	0.7
Class C	0.3	0.6	0.5	0.0	0.2	0.1
Class D	0.2	0.8	-0.1	0.1	0.3	0.7
Class E	-0.1	-0.4	-0.2	0.0	2.5	1.7
All	0.2	0.5	0.3	0.0	0.8	0.8
Enc Time[%]	93%					
Dec Time[%]	100%					

Conclusions

- Evaluated coding performance of current RQT with various max depth configurations.
  - Max depth set to 2 can obtain most coding gain compared with anchor condition (HE) and single size transformation.
- Proposed a method for encoder complexity reduction.
  - Reduce overall encoding time by 6-7% (anchor HE) with average 0.3% BD-rate increase.
- Proposed a couple of alternative TU representations
  - Reduced encoding time (scheme 1: 10%, scheme 2: 8%, HE)
  - Small BD-rate increase (scheme 1: 0.4%, scheme 2: 0.2%, HE)
  - Simplified TU syntax (both schemes)
- Recommendations
  - Include encoder complexity reduction in HM.
  - Consider adopting proposed alternative TU representations, or
  - Consider changing max RQT depth to 2, both Inter and Intra in HE anchor conditions.