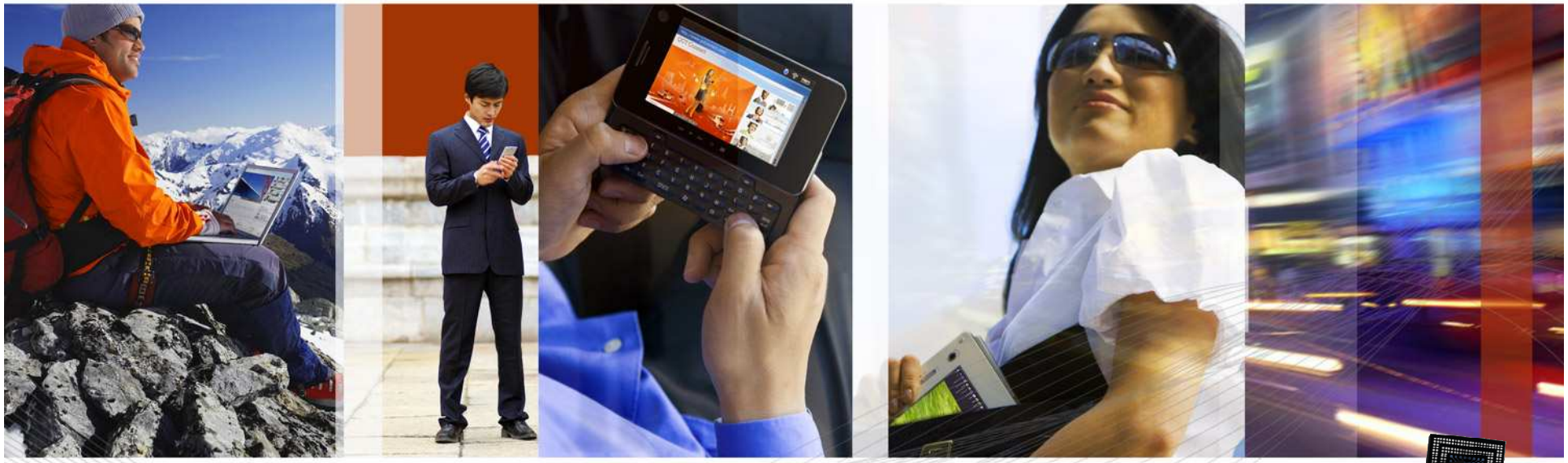

QUALCOMM CDMA Technologies

REDEFINING MOBILITY

Mode Dependent Hybrid Intra Smoothing

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Jan 2011

Introduction

- Adaptive intra smoothing (AIS) was proposed [1]:
  - RD-cost based filter decision
  - Increased encoder complexity
  - Signaling overhead

- Simplified adaptive intra smoothing [1]:
  - Only check the best mode for filtering decision
  - Reduced complexity, drop in performance

- Filtering decision based on a LUT[2] [3]:
  - Prediction unit size and prediction direction (LUT)
  - Reduced encoder complexity

Proposed mode dependent hybrid intra smoothing

- Filtering decision is based on
  - prediction unit (PU) size
  - prediction direction

- Given an intra prediction mode and PU size
  - Most probable filter → $LUT_{_most_probable_filter}$
  - Second most probable filter → $LUT_{_second_most_probable_filter}$
  - Intra smoothing filter is selected between these two filters

- Hybrid intra smoothing filter signaling
  - PU size >= 16x16, explicit signaling
  - PU size < 16x16, use most probable filter

PU Size	Filter
2x2	*most probable filter* (no signaling)
4x4	*most probable filter* (no signaling)
8x8	*most probable filter* (no signaling)
16x16	signaling
32x32	signaling
64x64	signaling
128x128	signaling

LUTs of probable filters

Most probable filter table: 0 – no filter, 1 – filter 1, 2 – filter 2

TU \ Mode	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
2x2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4x4	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8x8	0	0	0	1	1	2	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16x16	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32x32	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
64x64	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
128x128	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Second most probable filter table: 0 – no filter, 1 – filter 1, 2 – filter 2

TU \ Mode	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
2x2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4x4	1	1	1	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8x8	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16x16	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
32x32	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64x64	2	2	2	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
128x128	2	2	2	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Simulations

- Simulation setup:
  - Reference: TMuC 0.9 (no filtering)
  - QP = {22, 27, 32, 37}
  - JCTVC-C500 test conditions

- Simulations:
  - Test 1: Fixed – use only the *most probable filter* , no signaling
  - Test 2: Hybrid – signaling

Simulations: BD-rate saving

Configuration	Test 1 (Fixed)			Test 2 (Hybrid Signaling)		
	Y	U	V	Y	U	V
HE Intra	-0.3	-0.3	-0.4	**-0.5**	-0.5	-0.6
LC Intra	-0.7	-0.3	-0.3	**-0.9**	-0.4	-0.4
HE Random Access	-0.1	-0.4	-0.2	-0.2	-0.4	-0.3
LC Random Access	-0.1	-0.3	-0.2	-0.1	-0.2	-0.3
HE Low Delay	0.0	-0.4	-0.2	0.0	-0.4	-0.3
LC Low Delay	0.1	0.0	0.0	0.0	0.1	-0.1

Average BD-rate savings compared to TMuC 0.9 [%]

Simulations: Encoding/Decoding Time

Configuration	Test 1 (Fixed)		Test 2 (Hybrid Signaling)	
	Encoder	Decoder	Encoder	Decoder
HE Intra	101%	98%	101%	98%
LC Intra	98%	99%	99%	100%
HE Random Access	100%	100%	98%	100%
LC Random Access	99%	100%	98%	98%
HE Low Delay	98%	100%	96%	100%
LC Low Delay	100%	96%	100%	100%

Average encoding/decoding time ratio comparing to TMuC 0.9

CPU	MEM	OS	Compiler
Intel® Core™ i7, M620 @ 2.67GHz	4.00GB	64-bit Windows 7	MS Visual Studio 2008

Conclusion

- Proposed a mode dependent hybrid intra smoothing (MDHIS) approach
- Good tradeoff between coding efficiency and complexity
  - Improved coding gain
  - No significant encoder/decoder complexity increase
- Recommend proposed MDHIS for adoption in HM-1.0

Reference:

[1] Fraunhofer HHI, “Description of video coding technology proposal by Fraunhofer HHI”, JCT-VC, 1st Meeting, Dresden, Deutschland, April 2010, Doc. JCTVC-A116.

[2] K. McCann, W. Han, I. Kim, J. Min, E. Alshina, A. Alshin, T. Lee, J. Chen, V. Seregin, S. Lee, Y. Hong, M. Cheon, N. Shlyakhov, (Samsung Electronics Co., Ltd and British Broadcasting Corporation), “ Samsung’s Response to the Call for Proposals on Video Compression Technology”, 1st Meeting: Dresden, DE, 15-23 April, 2010, Doc. JCTVC-A124.

[3] Y. Zheng, M. Coban, and M. Karczewicz, “Simplified Intra Smoothing”, JCT-VC, 3rd Meeting, Guangzhou, China, Oct. 2010, Doc. JCTVC-C234.