JVET-K0359

Ljubljana, Slovenia

Qualcomm

CE9.2.5/9.2.6: DMVR with Template-free Bilateral Matching

Chun-Chi Chen, Wei-Jung Chien, Marta Karczewicz



Introduction

- Study template-free bilateral match for DMVR
  - Compute bilateral matching cost based on two unilateral prediction blocks
  - Update MV_{L0} and MV_{L1} respectively using +MVD and -MVD
  - Apply 2-tap bilinear filter for bilateral match
  - Apply 9-point search for integer-pel and half-pel
  - Switch distortion function (MRSAD or SAD) based on block size
  - Terminate MV refinement if MV differences between merge candidates are small
- Report Y BD-rate results against BMS (BMS-1.0 w/ BMS cfg.) & VTM (BMS-1.0 w/ VTM cfg.)
  - CE9.2.5 vs. BMS: (Y) -1.8%, (U) -1.6%, (V) -1.6%, (Enc.) 102%, (Dec.) 112%
  - CE9.2.6 vs. BMS: (Y) -1.4%, (U) -1.1%, (V) -1.2%, (Enc.) 100%, (Dec.) 108%
  - CE9.2.5 vs. VTM: (Y) -5.3%, (U) -4.7%, (V) -4.9%, (Enc.) 116%, (Dec.) 164%
  - CE9.2.6 vs. VTM: (Y) -4.8%, (U) -4.1%, (V) -4.3%, (Enc.) 112%, (Dec.) 150%

Proposed vs. DMVR

	DMVR in BMS-1.0	Proposed
Cost function	SAD between template and uni-lateral prediction block	MRSAD/SAD between uni-lateral prediction blocks
MV update	Independent search	Joint search with +MVD for MV_{L0} and –MVD for MV_{L1}
Search range	1 w/ 1 iteration	(CE9.2.5) 8 w/ 26 itr at maximum (CE9.2.6) 2 w/ 26 itr at maximum
Interpolation for search	8-tap DCTIF	(CE9.2.5) 8-tap DCTIF (CE9.2.6) 2-tap bilinear filter
Search method	9-point for int-pel	9-point for int-pel and half-pel
Additional early-termination condition	n/a	Based on MV differences of candidates (same as CE9.1.5)

Simulation Results vs. VTM

- CE9.2.5 vs. VTM and BMS

	Random Access Main 10									
	CE9.2.5 vs. VTM anchor					CE9.2.5 vs. BMS anchor				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-5.60%	-4.47%	-5.10%	112%	159%	-1.84%	-1.54%	-1.84%	100%	115%
Class A2	-8.86%	-7.87%	-7.96%	115%	180%	-2.65%	-2.22%	-2.31%	102%	112%
Class B	-4.62%	-3.97%	-4.04%	117%	158%	-1.57%	-1.42%	-1.36%	103%	110%
Class C	-3.18%	-3.39%	-3.47%	118%	165%	-1.29%	-1.23%	-1.27%	101%	113%
Overall	-5.28%	-4.70%	-4.88%	116%	164%	-1.76%	-1.55%	-1.62%	102%	112%
Class D	-3.36%	-3.25%	-3.40%	121%	167%	-1.55%	-1.39%	-1.22%	101%	112%

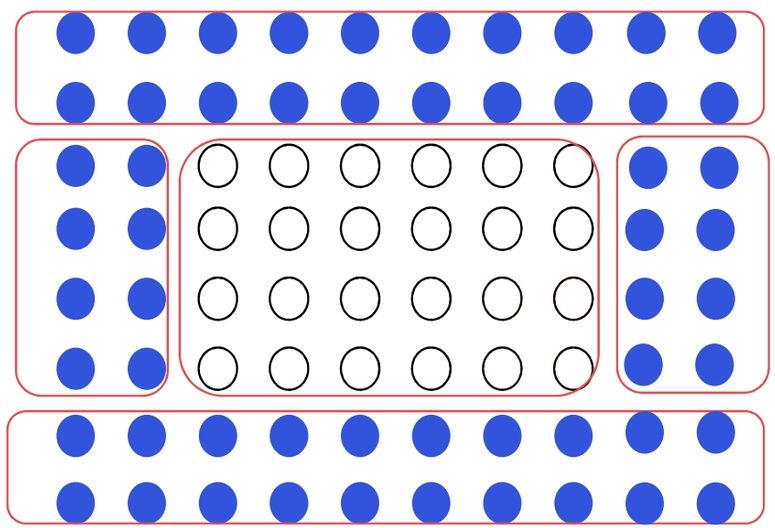
- CE9.2.6 vs. VTM and BMS

	Random Access Main 10									
	CE9.2.6 vs. VTM anchor					CE9.2.6 vs. BMS anchor				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-4.88%	-3.73%	-4.21%	108%	141%	-1.32%	-0.91%	-1.15%	99%	108%
Class A2	-8.07%	-7.13%	-7.30%	110%	159%	-2.10%	-1.63%	-1.83%	100%	107%
Class B	-4.30%	-3.56%	-3.66%	114%	152%	-1.35%	-1.13%	-1.12%	101%	108%
Class C	-2.77%	-2.95%	-3.00%	113%	150%	-0.99%	-0.93%	-0.94%	100%	107%
Overall	-4.76%	-4.15%	-4.32%	112%	150%	-1.40%	-1.13%	-1.22%	100%	108%
Class D	-3.05%	-3.01%	-3.24%	115%	153%	-1.32%	-1.15%	-1.11%	99%	106%

8-sample Alignment for Interpolation

- Make the most of SIMD to speed up interpolation during refinement (similar to CE9.2.9)
- Result in software-implementation-wise improvement on encoding/decoding time

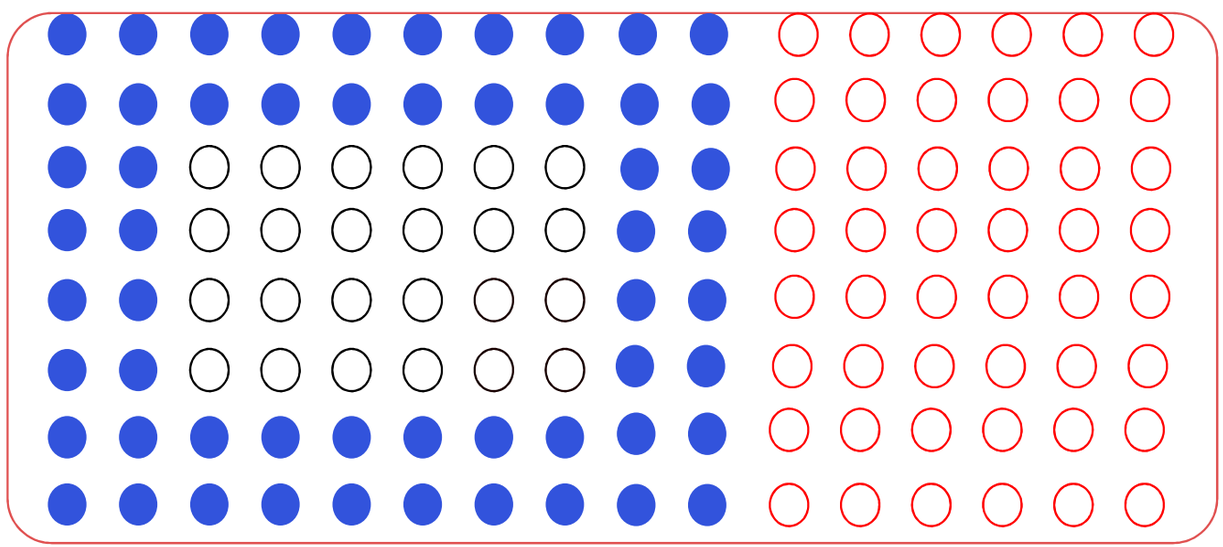
w/o alignment



e.g. 6x4 block w/ SR=2

Interpolation area = 10x8

w/ alignment



e.g. 6x4 block w/ SR=2

Interpolation area = 16x8 (6x8 at right-most side is not for search)

Additional Results w/ 8-sample Alignment for Interpolation

- CE9.2.6 vs. VTM and BMS (just for information, not cross-checked)
- 5% encoding-time reduction observed on VTM
- 10% and 5% decoding-time reduction respectively on VTM and BMS

	VTM		BMS	
	9.2.6	9.2.6 + align.	9.2.6	9.2.6 + align.
	EncT	EncT	EncT	EncT
Class A1	108%	107%	99%	99%
Class A2	110%	105%	100%	99%
Class B	114%	108%	101%	102%
Class C	113%	108%	100%	99%
Overall	**112%**	**107%**	**100%**	**100%**
Class D	115%	110%	99%	99%

	VTM		BMS	
	9.2.6	9.2.6 + align.	9.2.6	9.2.6 + align.
	DecT	DecT	DecT	DecT
Class A1	141%	137%	108%	101%
Class A2	159%	146%	107%	103%
Class B	152%	142%	108%	105%
Class C	150%	135%	107%	101%
Overall	**150%**	**140%**	**108%**	**103%**
Class D	153%	137%	106%	99%

Concluding Remarks

- Report results, including:
  - 1.4-1.8% and 4.8-5.3% BD-rate savings on BMS and VTM, respectively
  - 2% and 16% encoding-time increases on BMS and VTM, respectively
  - 10% and 50% decoding-time increases on BMS and VTM, respectively
- Observe 5-10% runtime reduction achievable by SIMD interpolation during MV refinement

- Thank **ETRI** and **Hulu** for crosscheck

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