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Title: **CE9: Summary report of core experiment on MV coding and Skip/Merge operations**

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Purpose: Report

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Source: CE coordinators

Abstract

In this CE report, test results of two different categories, modification of bi-prediction (BP) and simplification of the first merge pruning process (SP), are reported. Eight experiments for BP and one experiment for SP were conducted aligned with CE9 descriptions using HM-5.0 reference software under the common test condition described in JCTVC-G1200.

1 Introduction

~~Need to update~~The description of core experiment (CE) 9 on MV coding and Skip/Merge operations [1] was made in previous Geneva meeting. There are two categories in CE9 description: the modification of bi-prediction and a simplification of the first merge pruning process. Experiments were conducted aligned with CE9 descriptions in order to evaluate the coding efficiency and complexity for methods in each category. These experiments were conducted using HM-5.0 reference software under the common test condition described in JCTVC-G1200 [2].

2 Document lists

2.1 Modification of bi-prediction

Tester1

JCTVC-H0111 CE9: Modification of bi-prediction, Y. Suzuki (NTT DOCOMO)

Tester2

JCTVC-H0074 CE9: Cross-verification of BP03 (JCTVC-H0111), S. Fukushima, M. Ueda (JVC Kenwood)

JCTVC-H0217 CE9: Cross-check report of BP05 by Panasonic, T. Sugio, T. Nishi (Panasonic)

JCTVC-H0344 CE9: Cross-check report for tests BP01 and BP04 (JCTVC-H0111), P. Helle (Fraunhofer HHI)

JCTVC-H0583 CE9: cross-check of experiment BP02 and BP06 (JCTVC-H0583), J. Jung (Orange Labs)

JCTVC-H0625 CE9: Cross-check report on experiment BP07 and BP08 of JCTVC-H0111, I.-K Kim (Samsung)

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2.2 Simplification of the first merge pruning process

Tester1

JCTVC-H0252 CE9: Results of SP experiments on simplification of merge process, O. Bici, J. Lainema, K. Ugur (Nokia)

Tester2

JCTVC-H0143 CE9: Cross verification of Nokia's proposal JCTVC-G593, S. Lu, K. Sato (Sony)

~~*2.3 Related non-CE contributions*~~

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3 Description of experiments and summary results

In CE9, total 9 experiments, which are categorized into 2 groups, were conducted. Descriptions and results for these experiments are presented shortly in the following sections. Detailed descriptions can be found in JCTVC-G1209 [1] and detailed results are in the CE9 documents listed in section **Error! Reference source not found.**~~2~~. All experiments are conducted under common test conditions described in JCTVC-G1200 [2].

3.1 Modification of bi-prediction

3.1.1 Description of experiments

In this category, 8 experiments were conducted to verify the efficiency of ~~modification of~~ bi-prediction modification, which was originally presented in JCTVC-G305~~593, were conducted.~~. For all these tests, the only reference used is HM-5.0. In BP01, as ~~an~~ the original form of the proposal, the motion vector difference (MVD) for List1 ~~and List0~~ is not signaled and ~~it~~ sets to (0, 0) for GPB pictures (reference picture list 1 is identical to reference picture list 0). A variation, which alters L0 MVD instead of L1 MVD, is tested in BP02. In BP03, the same approach as BP01 is applied to all inter picture ~~sas well as GPB pictures~~. Also, in order to investigate the effects of syntax change, two experiments are done with encoder only changes in BP04 and BP05. The effect of combination with 2nd motion estimation for bi-prediction in non-GPB pictures is investigated by BP06. In BP07 and BP08, the same modifications to BP01 and BP02 are tested with the addition of ~~based on the another base software which~~ the ~~fix of~~ HM ticket #175 fix. The HM ticket #175 –is applied since this fix ~~HM ticket #175~~ is related to the ~~enhancement of~~ bi-predictive motion estimation (ME) enhancement. The impact on visual quality by the modification of ME part is also investigated.

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Table 1. Description of experiments for modification of bi-prediction (BP-series)

Test	Description	Tester1 (document number)	Tester2 (document number)	S/W release date
BP01	L1 MVD is set to (0,0) and not signalled for GPB pictures	NTT DOCOMO (JCTVC-H0111)	HHI (JCTVC-H0344)	28. Dec
BP02	L0 MVD is set to (0,0) and not signalled for GPB pictures	NTT DOCOMO (JCTVC-H0111)	Orange Labs (JCTVC-H0583)	28. Dec
BP03	L1 MVD is set to (0, 0) and not signalled for all inter pictures (RA conditions only)	NTT DOCOMO (JCTVC-H0111)	JVC Kenwood (JCTVC-H0074)	28. Dec
BP04	L1 MVD is set to (0, 0) at encoder for GPB pictures	NTT DOCOMO (JCTVC-H0111)	HHI (JCTVC-H0344)	28. Dec
BP05	HM5.0 with the 2nd motion estimation for bi-prediction	NTT DOCOMO (JCTVC-H0111)	Panasonic (JCTVC-H0217)	28. Dec
BP06	BP01 with the 2nd motion estimation for bi-prediction in non-GPB pictures (RA conditions only)	NTT DOCOMO (JCTVC-H0111)	Orange Labs (JCTVC-H0583)	28. Dec
BP07	HM5.0 with HM ticket #175	NTT DOCOMO (JCTVC-H0111)	Samsung (JCTVC-H0625)	28. Dec
BP08	BP01 with HM ticket #175	NTT DOCOMO (JCTVC-H0111)	Samsung (JCTVC-H0625)	28. Dec

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3.1.2 Summary of experimental results

Table 2. Summary of experimental results for modification of bi-prediction (BP series)

	RA-HE		RA-LC		RA-HE-10bit		LD-HE		LD-LC	
	RD-Rate	Enc./Dec. Time	RD-Rate	Enc./Dec. Time	RD-Rate	Enc./Dec. Time	RD-Rate	Enc./Dec. Time	RD-Rate	Enc./Dec. Time
BP01	-0.2	99 / 100	-0.2	99 / 100	-0.3	99 / 100	-0.8	100 / 100	-1.1	99 / 100
xCheck	-0.2	99 / 100	-0.2	99 / 100	-0.3	99 / 100	-0.8	99 / 100	-1.1	99 / 100
BP02	-0.2	99 / 100	-0.2	99 / 101	-0.2	99 / 100	-0.8	99 / 100	-1.1	99 / 100
xCheck	-0.2	100 / 104	-0.2	100 /103	missing-	missing-	-0.8	100 / 100	-1.1	99 / 99
BP03	1.0	99 / 101	0.9	99 / 100	0.8	99 / 100	-0.8	99 / 100	-1.1	99 / 100
xCheck	1.0	99 / 101	0.9	99 / 101	0.8	99 /100	-	-	-	-
BP04	0.0	99 / 100	0.0	99 / 100	-0.1	99 / 100	-0.1	99 / 100	-0.4	99 / 100
xCheck	0.0	100 / 100	0.0	99 /99	-0.1	100 / 100	-0.1	99 / 100	-0.4	99 / 100
BP05	-0.5	120 / 100	-0.7	124 / 100	-0.7	120 / 100	-0.5	129 / 100	-0.8	132 / 100
xCheck	-0.5	118 / 101	-0.7	123 / 101	-0.7	118 / 101	-0.5	124 / 100	-0.8	130 / 100
BP06	-0.6	117 / 101	-0.7	120 / 101	-0.7	117 / 100	-0.8	100 / 100	-1.1	99 / 100
xCheck	-0.6	116 / 100	-0.7	119 / 101	missing-	missing-	-	-	-	-

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BP07	-0.1	100 / 100	0.0	100 / 100	0.0	99 / 98	0.0	100 / 100	-0.1	100 / 99
xCheck	-0.1	100 / 102	0.0	100 / 100	0.0	100 / 100	0.0	100 / 100	-0.1	100 /101
BP08	-0.3	99 / 100	-0.3	99 / 100	-0.3	99 / 100	-0.9	99 / 100	-1.2	99 / 100
xCheck	-0.3	100 / 101	-0.3	99 / 101	-0.3	100 / 100	-0.9	100 / 100	-1.2	99 / 101

3.1.3 Comments from cross-checkers

Informal subjective quality evaluation results are included in a cross-check report (JCTVC-H0344). The author examined several reconstructed class B and C sequences of BP08 for the configurations LDHE, LDLC and RAHE with QP 32 and 37. The sequences were viewed on an ordinary PC-monitor at a viewing distance of about 0.7m. When playing back the reconstructed sequences at the intended frame rate, no artifacts matching the reported description "blocks standing still for some frames and then moving fast" or any other unusual artifacts could be observed. The cross-checker concludes that BP08 does not show any unusual or undesired effect on reconstruction quality to the author of this document.

~~Need to update~~

3.2 Simplification of the first merge pruning process

3.2.1 Description of experiments

In this test, the first pruning process in HM5.0 is removed and instead, a smaller number of parallelizable motion information comparisons are performed only between the spatial candidates. The motion information of a spatial candidate is inserted into the merge list depending of a specific condition on this spatial candidate. The conditions for each spatial candidate to be excluded from the merge list are as follows:

- A1: No change
- B1: B1 has the same motion information as A1
- B0: B0 has the same motion information as B1
- A0: A0 has the same motion information as A1
- B2: B2 has the same motion information as A1 or has the same motion information as B1

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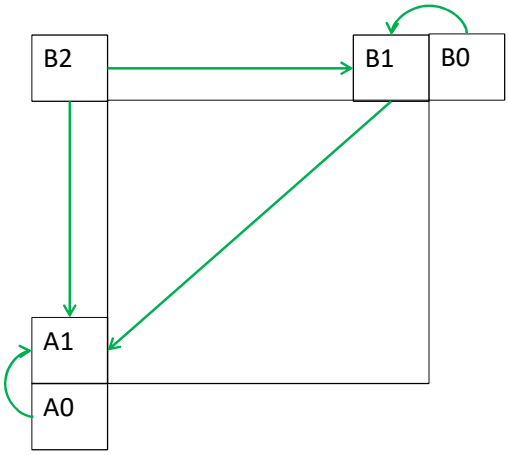

Figure 1. Spatial neighbors which are the potential candidates for the merge list. Arrows indicate which spatial candidate(s) are to be compared.

Table 3. Description of experiment for simplification (SP)

Test	Description	Tester1 (document number)	Tester2 (document number)	S/W release date
SP	The first merge pruning process using parallelizable motion information comparisons on the spatial candidates	Nokia (JCTVC-H0252)	Sony (JCTVC-H0143)	4. Jan (2 day behind deadline)

3.2.2 Summary of experimental results

Table 4. Summary of experimental results for SP

	RA-HE		RA-LC		RA-HE-10bit		LD-HE		LD-LC	
	RD-Rate	Enc./Dec. Time	RD-Rate	Enc./Dec. Time	RD-Rate	Enc./Dec. Time	RD-Rate	Enc./Dec. Time	RD-Rate	Enc./Dec. Time
SP	0.0	102 / 97	0.0	100 / 100	0.0	101 / 99	0.1	100 / 100	0.1	100 / 98
xCheck	0.0	100 / 98	0.0	100 / 99	0.0	100 / 99	0.1	100 / 99	0.1	100 / 98

3.2.3 Comments from cross-checkers

This method is recommended to be adopted by a cross-checker in JCTVC-H0143. The author claimed that this method can reduce merging complication and is friendly with hardware and software implementation

4 Conclusions

Summary of BP-series tests:

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- LD (LD-HE, LD-LC)

1. Gain of BP08 (including a syntax addition and bi-predictive ME fix) is 1.1% in average without encoding and decoding time increase for classes A-E. For class F is 1.9% in average. The cross-checker concludes that BP08 does not show any unusual or undesired effect on reconstruction quality.
2. Gain of BP05 (gain from encoder only 2nd motion estimation for bi-predictive mode) is 0.7 % in average with 31% encoding time increase for classes A-E. For class F is 0.7% in this case. It is worth noting that BP05 does not include bi-predictive ME fix. (With bi-predictive ME fix, the gain will increase to 0.7% for classes A-E case and 1.7% for class F case, respectively. These results are reported in JCTVC-H0111).
3. Gain from adding a syntax element is average 0.7%, which is derived by comparing results between BP01 and BP04.

- RA (RA-HE, RA-LC, RA-HE-10 bits)

1. Gain of BP08 (including a syntax addition and bi-predictive ME fix) is 0.37%~~–~~ in average without encoding and decoding time increase for classes A-E. For~~Gain of~~ class F is 0.7~~1.3~~%~~–~~ in average. The cross-checker concludes that BP08 does not show any unusual or undesired effect on reconstruction quality.
2. Gain of BP05 (gain from encoder only 2nd motion estimation for bi-predictive mode) is 0.6 % in average with 21~~5~~% encoding time increase for classes A-E. For~~Gain of~~ class F is 0.4% in this case. It is worth noting that BP05 does not include bi-predictive ME fix. (With bi-predictive ME fix, the gain will increase to 0.7% for classes A-E case and 1.1~~4~~% for class F case, respectively. These results are reported in JCTVC-H0111).
3. Gain of BP06 (gain from BP01 + encoder only 2nd motion estimation for bi-predictive mode) is 0.7 % in average with 18% encoding time increase for classes A-E. For class F is 0% in this case. It is worth noting that BP06 does not include bi-predictive ME fix. (With bi-predictive ME fix, the gain will increase to 0.7% for classes A-E case and 1.1% for class F case, respectively. These results are reported in JCTVC-H0111).

~~1.~~4. Gain from adding a syntax element is average 0.2~~4~~ %, which is derived by comparing results between BP01 and BP04.

Summary of SP test:

- SP is reported 0.1% loss in average. But it is claimed to have several benefits: reduction of complexity of merge list generation, decoding time reduction by early exit and improved error resilience.

Recommendations

- Fix the HM ticket #175
- Recommend BP08 as the best method among 8 test cases and BP08 will be discussed as a candidate of adoption at the meeting with non-CE contributions.

5 References

[1] I.-K Kim, J. Jung and S. Oudin, "Description of Core Experiment 9 (CE9): MV Coding and Skip/Merge Operations," Document of Joint Collaborative Team on Video Coding, JCTVC-G1209, Nov. 2011.

[2] F. Bossen, "Common HM test conditions and software reference configurations," Document of Joint Collaborative Team on Video Coding, JCTVC-G1200, Nov. 2011.

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