Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
6th Meeting: Torino, IT, 14-22 July, 2011

Document: JCTVC-F419

Title:	**Unification of derivation process for merge mode and MVP**
Status:	Input Document to JCT-VC
Purpose:	Proposal

Author(s) or Contact(s):
Hiroya Nakamura
Shigeru Fukushima
Masayoshi Nishitani
JVC KENWOOD Holdings, Inc.
58-7, Shinmei-cho, Yokosuka,
Kanagawa 239-8550, Japan

Tel: +81-46-836-6459
Email:
nakamura.hiroya@jk-holdings.com
fukushima.shigeru@jk-holdings.com
nishitani.masayoshi@jk-holdings.com

Source: JVC KENWOOD Holdings, Inc.

Abstract

This contribution presents simplifications of derivation process for merge mode and motion vector predictor (MVP). In this proposal, the positions of the spatial neighbors that can be used as merging candidates are as same as the positions of the spatial MVP candidates. That is unification of the location of spatial neighbors for merge mode and MVP. In addition, the proposed techniques attempt unification of the derivation process for merge mode and MVP. This proposal tries to reduce the number of candidates in the spatial derivation process to reduce the number of times of comparison in the removal process.

The simulation results indicate that the proposed technique provides 0.1-0.2% BD-rate loss for random access, and 0.0-0.2% loss for low delay.

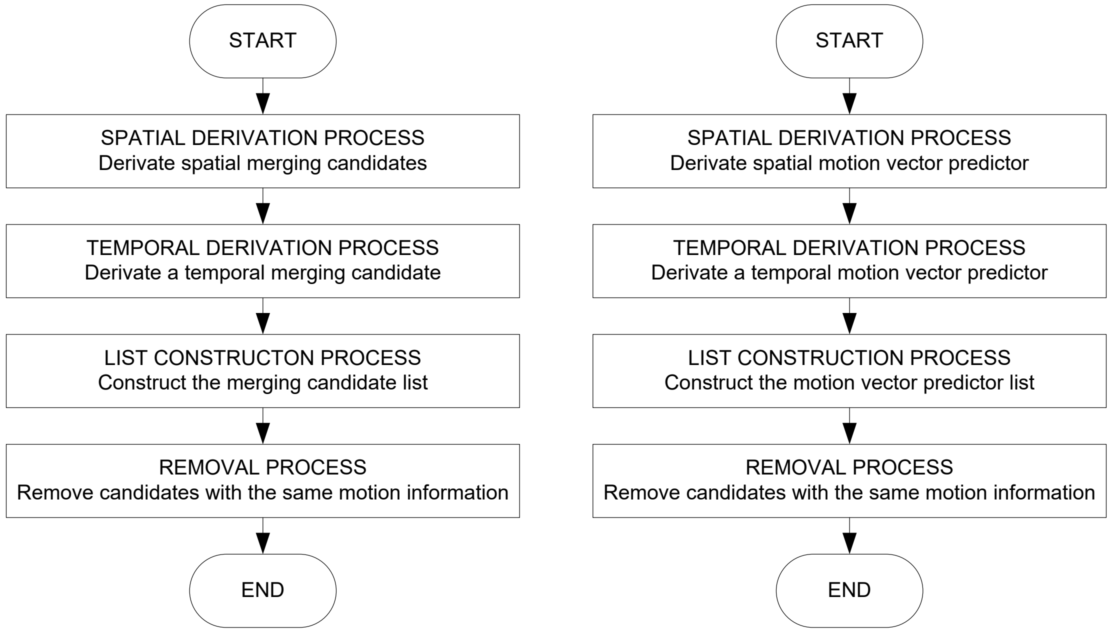
1 Introduction

This proposal is for the improvement of derivation method of the candidates for merge mode and motion vector predictor (MVP). In this proposal, the positions of the spatial neighbors that can be used as merging candidates are as same as the positions of the spatial MVP candidates. That is unification of the location of spatial neighbors for merge mode and MVP. In addition, the proposed techniques attempt unification of the derivation process for merge mode and MVP.

2 Proposed techniques

2.1 *Derivation process for merge mode and MVP*

Figure 1 (a) and (b) illustrate the derivation process for merge mode and motion vector predictor (MVP) in the WD3 [1].



(a) Derivation Process for merge mode (b) Derivation Process for motion vector predictor

Figure 1 Derivation Process of merge mode and MVP in WD3

2.2 Proposed techniques

The proposed techniques simplify the derivation process for merge mode and MVP.

2.2.1 Proposal 1: Proposed technique for merge mode

Changes of our proposal for merge modes from HM3.0 are as follows:

- The positions of the spatial neighbors that can be used for merging candidates are as same as the positions of the spatial MVP candidates. That is unification of the location of spatial neighbors for merge mode and MVP.
- Two spatial merging candidates are derived in the spatial derivation process.
- The merging candidate list is constructed of two spatial merging candidates and a temporal merging candidate.

Figure 2 (a) and (b) illustrate the position of the spatial neighbors A, B, C, D and E relative to the current prediction unit in the HM3.0 and the proposed technique, respectively.

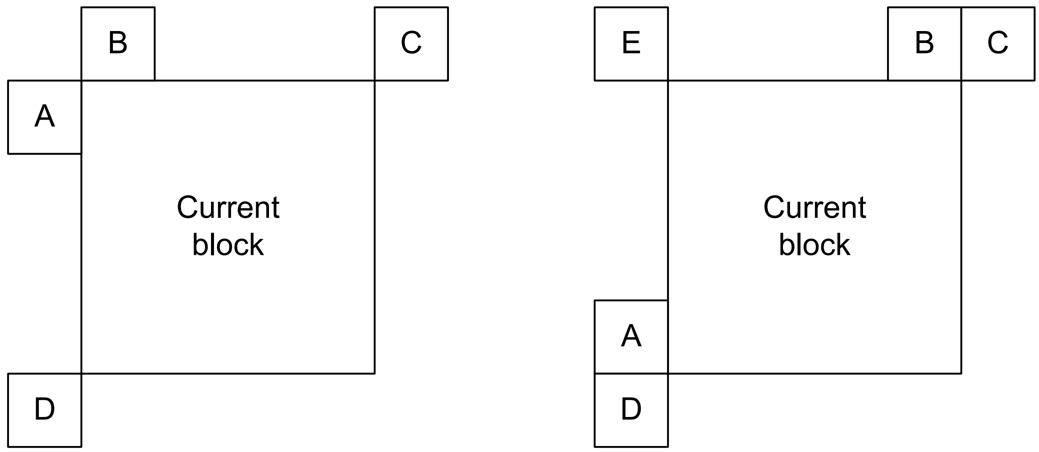


Figure 2 Spatial neighbors that can be used as merging candidates.

In this proposal, two spatial candidates and a temporal candidate are derived. The number of candidates is reduced in the spatial derivation process to reduce the number of times of comparison in the removal process. Table 1 presents the number of times of comparison in the removal process in each the number of candidates. The number of times of comparison in the removal process in HM3.0 is ten times. On the other hand, the number of times of comparison in the removal process in the proposed technique is three times.

Table 1 The number of comparison in the removal process

The number of candidates in the spatial and temporal derivation process	The number of times of comparison in the removal process	Notes
3 (=2+1)	3 [times]	Proposed technique
4 (=3+1)	6 [times]	-
5 (=4+1)	10 [times]	HM3.0
6 (=5+1)	15 [times]	-

Table 2 presents the comparison between HM3.0 and proposed technique for merge mode.

Table 2 Comparison between HM3.0 and proposed technique for merge mode

	HM3.0	Proposal 1
The number of spatial candidates	4 in 4 [positions]	2 in 5 [positions]
Spatial derivation order	A, B, C, D	A, B, C, D, E
The number of times of comparison of redundant candidates in the spatial derivation process	0 [time]	0 [time]
The number of temporal candidates	1	1
Merging candidate list order	A, B, Col, C, D	S_0, S_1, Col
The number of times of comparison in the removal process	10 [times] (A vs B, Col, C, D, B vs Col, C, D, Col vs C, D, and C vs D)	3 [times] (S_0 vs S_1, S_0 vs Col, and S_1 vs Col)

Notes:

S_0: The first spatial candidate found in the spatial derivation process

S_1: The second spatial candidate found in the spatial derivation process

2.2.2 Proposal 2: Proposed technique for motion vector predictor (MVP)

Changes of our proposal for MVP from HM3.0 are as follows:

- Two in five spatial candidates are derived without grouping of the neighbors in the spatial derivation process.
- The comparison step is not used in the spatial derivation process.

Figure 3 (a) and (b) illustrate the position of the spatial neighbors relative to the current prediction unit in HM3.0 and proposal, respectively.

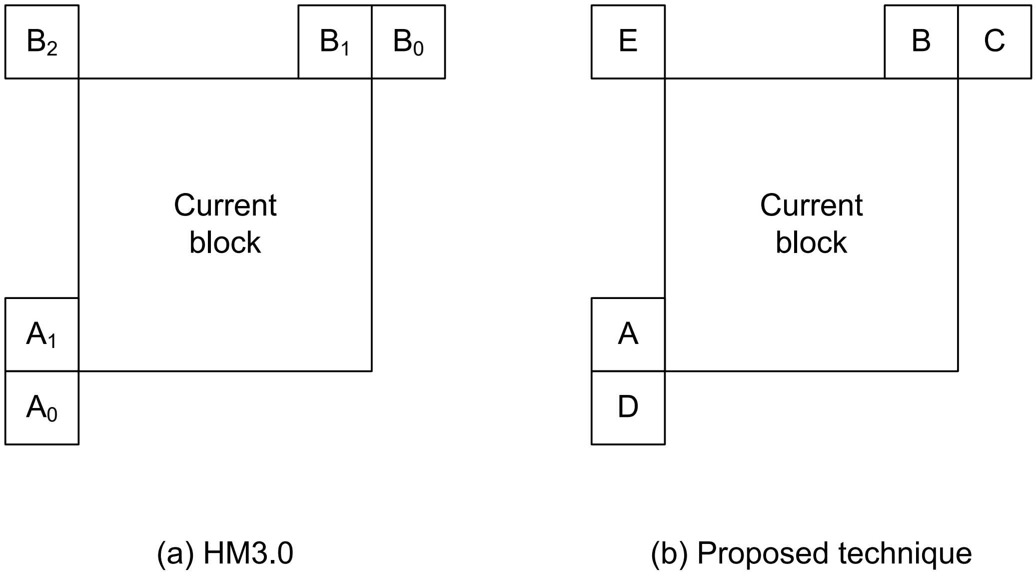


Figure 3 Spatial motion vector neighbors that can be used as MVP candidates.

In this proposal, two spatial candidates and a temporal candidate are derived. The removal process in the spatial derivation process is not applied.

Table 3presents the comparison between HM3.0 and proposed technique for merge mode.

Table 3 Comparison of HM3.0 between HM3.0 and proposed technique for MVP

	HM3.0	Proposal 2
The number of spatial candidates	2 in 5 [positions]	2 in 5 [positions]
Grouping of the neighbors in the spatial derivation process	Group A: Left (A_0, A_1) Group B: Upper (B_0, B_1, B_2)	without grouping
Spatial derivation order	Group A: A_0, A_1 Group B: B_0, B_1, B_2	C, D, A, B, E
The number of times of checking per spatial neighbors in the spatial derivation process	2 [times]	1 [time]
The number of times of comparison of redundant candidates in the spatial derivation process	6 [times] (mvLXA vs $mvLXB_0$, mvLXA vs $mvLXB_1$, and mvLXA vs $mvLXB_2$) x 2	0 [time]
The number of temporal candidates	1	1
MVP list order	mvLXA, mvLXB, mvLXCol	$mvLXS_0$, $mvLXS_1$, mvLXCol
The number of times of comparison in the removal process	2 [times] (mvLXA vs mvLXCol, and mvLXB vs mvLXCol)	3 [times] ($mvLXS_0$ vs $mvLXS_1$, $mvLXS_0$ vs mvLXCol, and $mvLXS_1$ vs mvLXCol)

Notes:

$mvLXS_0$: MVP of the first spatial candidate found in the spatial derivation process

$mvLXS_1$: MVP of the second spatial candidate found in the spatial derivation process

2.2.3 Proposal 1 and 2: Unification of derivation process for merge mode and motion vector predictor (MVP)

Table 4 presents the comparison of derivation process between merge mode and MVP in the proposal.

Table 4 Comparison of derivation process between merge mode and MVP

	Proposal 1: merge mode	Proposal2: MVP
The number of spatial candidates	2 of 5	2 of 5
Grouping in the spatial derivation process	without grouping	without grouping
Spatial derivation order	A, B, C, D, E	C, D, A, B, E
The number of times of comparison of redundant candidates in the spatial derivation process	0 [time]	0 [time]
The number of temporal candidates	1	1
Merge/MVP list order	S_0, S_1, Col	$mvLXS_0$, $mvLXS_1$, mvLXCol
The number of times of comparison in the removal process	3 [times] (S_0 vs S_1, S_0 vs Col, and S_1 vs Col)	3 [times] ($mvLXS_0$ vs $mvLXS_1$, $mvLXS_0$ vs mvLXCol, and $mvLXS_1$ vs mvLXCol)

2.3 Implementation

2.3.1 Software

This proposed technique is implemented into HM3.0 software (CE1/CE9 anchor: revision 828).

2.3.2 Syntax structure

The syntax of this proposed technique is not revised from HM3.0.

3 Experiments

3.1 Test conditions

The common test conditions [2] are used.

3.2 Simulation environments

Table 5 and Table 6 show the simulation environments for encoding and decoding experiments, respectively.

Table 5 Simulation environment for encoding experiments

CPU	Intel Core i7 870 2.93GHz
Memory	16GB (DDR3)
OS	Windows 7 Professional 64bit
Compiler	Microsoft Visual C++ 2008 Express edition SP1
Executable	x64

Table 6 Simulation environment for decoding experiments

CPU	Intel Core i7 870 2.93GHz
Memory	16GB (DDR3)
OS	Windows 7 Professional 64bit
Compiler	Microsoft Visual C++ 2008 Express edition SP1
Executable	x64

Notes: The decoding time is measured with the writing of yuv file.

3.3 Simulation results

3.3.1 Simulation results only applying Proposal 1 (merge mode)

Table 7 and Table 8 report the simulation results only applying Proposal 1 for random access and low delay, respectively.

Table 7 Simulation results of Proposal 1 for random access

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.1	0.1	0.1	0.2	0.1	0.0
Class B	0.1	0.0	0.0	0.2	0.1	0.1
Class C	0.0	0.2	0.2	0.2	0.1	0.2
Class D	0.1	0.1	0.0	0.1	0.0	0.0
Class E						
Overall	**0.1**	**0.1**	**0.1**	**0.2**	**0.1**	**0.1**
Enc Time[%]	99%			99%		
Dec Time[%]	101%			101%		

Table 8 Simulation results of Proposal 1 for low delay

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.1	0.3	0.0	0.3	0.0	0.2
Class C	0.1	-0.1	0.1	0.1	0.0	0.0
Class D	0.0	-0.3	0.4	0.2	0.0	-0.1
Class E	-0.1	0.4	-0.3	0.2	-0.2	0.6
Overall	**0.1**	**0.1**	**0.1**	**0.2**	**0.0**	**0.1**
Enc Time[%]	99%			99%		
Dec Time[%]	100%			99%		

The simulation results report that the proposed technique provides 0.1-0.2% loss BD-rate [3] for random access, and 0.1-0.2% loss for low delay with 99% encoder runtime and 99-101% decoder runtime. (See the attached excel sheet)

3.3.2 Simulation results only applying Proposal 2 (MVP)

Table 9 and Table 10 report the simulation results only applying Proposal 2 for random access and low delay, respectively.

Table 9 Simulation results of Proposal 2 for random access

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.0	0.1	0.0	0.1	0.2	0.0
Class B	0.0	0.0	-0.1	0.0	0.0	0.0
Class C	0.0	0.0	0.1	0.1	0.0	0.0
Class D	0.1	0.1	0.0	0.0	-0.1	-0.1
Class E						
Overall	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**
Enc Time[%]	100%			100%		
Dec Time[%]	101%			101%		

Table 10 Simulation results of Proposal 2 for low delay

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.0	0.1	-0.2	0.0	-0.1	0.0
Class C	0.0	0.1	0.0	0.0	-0.1	-0.2
Class D	0.0	0.0	0.5	0.0	-0.3	0.0
Class E	0.0	0.6	0.0	0.0	0.1	0.2
Overall	**0.0**	**0.1**	**0.1**	**0.0**	**-0.1**	**0.0**
Enc Time[%]	100%			99%		
Dec Time[%]	102%			101%		

The simulation results report that the proposed technique provides no loss for both random access, and for low delay with 100% encoder runtime and 100-102% decoder runtime. (See the attached excel sheet)

3.3.3 Simulation results applying Proposal 1 and 2 (merge mode and MVP)

Table 11 and Table 12 report the simulation results applying Proposal 1 and 2 for random access and low delay, respectively.

Table 11 Simulation results for random access

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.1	0.1	0.3	0.2	0.2	0.0
Class B	0.1	0.0	0.0	0.2	0.1	0.1
Class C	0.1	0.1	0.1	0.2	0.2	0.3
Class D	0.1	0.1	0.0	0.1	0.0	0.0
Class E						
Overall	**0.1**	**0.1**	**0.1**	**0.2**	**0.1**	**0.1**
Enc Time[%]	99%			99%		
Dec Time[%]	101%			101%		

Table 12 Simulation results for low delay

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.1	0.2	-0.2	0.3	0.1	0.1
Class C	0.1	0.1	0.0	0.2	0.1	0.0
Class D	0.0	-0.3	0.6	0.2	-0.2	0.0
Class E	0.0	0.0	-0.1	0.1	-0.3	0.3
Overall	**0.0**	**0.0**	**0.1**	**0.2**	**0.0**	**0.1**
Enc Time[%]	98%			99%		
Dec Time[%]	102%			101%		

The simulation results report that the proposed technique provides 0.1-0.2% BD-rate loss for random access, and 0.0-0.2% loss for low delay with 98-99% encoder runtime and 101-102% decoder runtime. (See the attached excel sheet)

4 Conclusions

We recommend that the proposed technique be further studied in CE activity.

5 Future Work

We would like to study in CE activity as follows:

- Each of the number of spatial candidates (2, 3, 4 and 5).
- Each of the method (the number of times) of checking in the spatial derivation process
- Comparison/no comparison of redundant candidates in the spatial derivation process
- Evaluation of this proposed technique under robustness conditions

6 References

[1] "WD3: Working Draft 3 of High-Efficiency Video Coding",

JCTVC-E603, Geneva, March 2011

[2] Frank Bossen "Common test conditions and software reference configurations", JCTVC-E700, Geneva, March 2011

[3] G. Bjøntegaard, "Improvements of the BD-PSNR model," ITU-T SG16 Q.6 Document, VCEG-AI11, Berlin, July 2008.

7 Patent rights declaration(s)

JVC KENWOOD Holdings, Inc. and Victor Company of Japan, Limited may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).