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SOURCE : Japan
TITLE : Selecting rule of reference pictures in the low delay mode
PURPOSE : Proposal
Relevant sub-group : Video

1.Introduction

Low delay coding scheme should be treated in the framework of main profile as much as possible. So picture skipping is also essential to be included in the main profile. Once picture skipping takes place, some pictures lose their reference pictures. And for these cases, it is not clearly defined how to select the reference pictures.

The purpose of this document is to consider how to select the reference pictures so that it is adoptable in any case, and to estimate hardware impact of supporting picture skipping.

2.Results of consideration

This consideration is based on the following three conditions.

C1) The difficulty of enlarging the search area of motion vectors can be solved with some technique like telescopic search, though it is a mere encoder matter.

C2) Two reference pictures are used in the Field picture as much as possible.

C3) There is a picture header detector at the input of the decoder. This detector can analyze the picture_coding_type field.

The following points are clarified through this consideration. The details are attached in Annex A.

R1) In order to include S-picture in the main profile, selecting rule of the reference pictures should be modified as follows.

[Frame picture]

For the forward prediction mode, either of the latest decoded P-picture or I-picture which precedes the currently processed picture both in the source order and in the coding order, can be used as the reference picture. For the backward prediction mode, either of the latest decoded P-picture or I-picture which follows the currently processed picture in the source order and precedes it in the coding order, can be used as the reference picture, if it exists.

[Field picture]

For the forward prediction mode, the latest decoded P-pictures or I-pictures in both field parities which precede the currently processed picture both in the source order and in the coding order, can be used as the reference pictures. For the backward prediction mode, the latest decoded P-pictures or I-pictures in both field parities which follow the currently processed picture in the source order and precede it in the coding order, can be used as the reference pictures, if they exist.

R2) The hardware impact of supporting picture skipping is never significant, though the switching controller of the reference buffer planes may be slightly complex.

3.Conclusion

It is proposed that selecting rule of the reference pictures is modified as described above. From the aspect of video specifications, it is reasonable and preferable that S-picture (Skipped picture) is treated in the framework of the main profile.

Further study is required from the point of system specifications, though no critical problems have been identified up to now.

END

Annex A Detail of consideration

1. Frame picture, M=1, without I-picture
source order : P1 P2 P3 P4 P5 P6 P7 P8 P9 P10 P11
[case1]
coding order : P1 P2 P3 P4 (P5) (P6) (P7) P8 P9 P10 P11
(**) stands for S-picture

[case1]

In case that a scene change takes place between P3 and P4, and that P5,P6 and P7 become S-pictures, it is reasonable that P4 is selected for the reference picture of P8. Additional load of decoder hardware is only the controller logic which does not renew the reference buffer and display buffer.

2. Field picture, M=1, without I-picture
source order : P1 P3 P5 P7 P9 P11
P2 P4 P6 P8 P10 P12
[case2]
coding order : P1 P3 (P5) P7 P9 P11
P2 (P4) P6 P8 P10 P12
reference#1 P0 ------ P3 ---------- P8 ------- P11 ---
reference#2 P1 ---------- P6 ------- P9 -------- P12
reference#3 P2 ---------- P7 ------- P10 ----------
[case3]
coding order : P1 P3 P5 P7 P9 P11
P2 (P4) (P6) P8 P10 P12
reference#1 P0 ------ P3 ---------- P7 ----------
reference#2 P1 ---------- P5 ------- P8 ----------
reference#3 P2 ---------- P9 ----------

[case2]

This is the case that a scene change takes place between P2 and P3, and that P4 and P5 become S-pictures. According to the consideration of case1, P2 and P3 become the reference pictures of P6, and P3 and P6 become the reference pictures of P7. This example seems to tell us that we can select the latest two decoded fields for the reference pictures.

[case3]

This is the case of inserting contiguous 2 fields (P3,P4) that have different scene compared with their neighbors. Namely the first scene change takes place between P2 and P3, and the second scene change takes place between P4 and P5. According to the previous rule, P3 and P5 become the reference pictures of P7. As these two pictures have same field parity, it is impossible to distinguish these two reference pictures by means of motion_vertical_field_select field in the macroblock header. To solve this problem selection rule of reference pictures should be modified as "the latest decoded pictures in both field parities which precede the currently processed picture can be selected for the reference pictures". According to this new rule, the reference pictures of P7 are P2 and P5 and those of P8 are P2 and P7.

Concerning the additional load of decoder hardware, the controller of the reference buffer becomes slightly complex, because the reference buffer plane which should be written next isn't cyclically decided as shown in the above figure. But the amount of the buffer memory does not increase, so the hardware impact is negligibly small.

3. Field picture, M=2, without I-picture

```
source order  : B1   P3   B5   P7   B9   P11   B13
                   B2   P4   B6   P8   B10   P12   B14
[case4]
coding order  :      P3   B1   P7   (B5)  P11   B9
                       P4   B2   (P8)  B6    P12   B10
reference#1  P-1 ---------- P7 ----------
reference#2  P0  ----------------------------------------
reference#3  P-5 ----- P3 ---------- P11 ----------
reference#4  P-4 --------- P4 ---------- P12 ------
[case5]
coding order  :      P3   (B1)  (P7)  (B5)  (P11)  B9    P15
                       (P4)  (B2)  (P8)  B6   (P12)  B10   P16
reference#1  P-1 ---------------------------------------- P15 ---
reference#2  P0  ----------------------------------------------------
reference#3  P-5 ----- P3 ----------------------------------------
reference#4  P-4 ---------------------------------------- P16
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[case4]

This is the case that P8 and B5 become S-pictures because of a scene change between B6 and P7. Before examining this case, we should modify our selection rule of reference pictures in the Field picture as follows.

> For the forward prediction mode, the latest decoded P-pictures or I-pictures in both field parities which precede the currently processed picture both in the source order and in the coding order, can be used as the reference pictures. For the backward prediction mode, the latest decoded P-pictures or I-pictures in both field parities which follow the currently processed picture in the source order and precede it in the coding order, can be used as the reference pictures, if they exist.

Now the reference pictures of B6 are P3,P4 and P7 (note that P8 does not exist due to picture skipping), and those of P11 are P4 and P7. There is no inconsistency of logic. And hardware impact is rather small similarly to the previous cases.

[case5]

This is the case that the first scene change between B2 and P3 subjects P4,B1,B2,P7, P8 and B5 to S-pictures, and that the second scene change between B5 and B6 subjects P11 and P12 to S-pictures. According to the latest rule, P0 and P3 are reference pictures of B6,B9, B10,P15 and P16. Though prediction efficiency may be worse, there is no inconsistency. And hardware impact is small.

4.Field picture, M=2, with I-picture

```
source order  : B1   P3   B5   P7   B9   I11   B13   P15   B17   P19
                   B2   P4   B6   P8   B10   P12   B14   P16   B18   P20
[case6]
coding order  :      P3   B1   P7   (B5)  (I11)  B9    P15   B13   P19
                       P4   B2   (P8)  (B6)   P12   B10   P16   B14   P20
reference#1  P-1 ---------- P7 ---------------------------------------- P19 ---
reference#2  P0  ---------------------------------- P12 ---------------------- P20
reference#3  P-5 ----- P3 ---------------------------------- P15 ----------
reference#4  P-4 --------- P4 ---------------------------------- P16 ----------
```

[case6]

If P8,B5,B6,I11 become S-pictures because of the scene change between B6 and P7, the reference pictures of B9 and B10 are P4,P7 and P12, and those of P15 are P7 and P12. The reference picture of P12 is irregularly decided to P7, because P12 is the first even (bottom) field of the GOP. Considering the editing of the GOP including (I11) in the bitstream level, there is a problem that image quality of P12,B13, B14 and P15 is rather bad due to lack of encoded P7 in the composed bitstream. But this is not serious because

1)this area is not in the steady state but the transient state, so image quality is out of consideration

2)editing the bitstream by GOP has inherently inconsistency at the end of the GOP. In terms of the hardware impact, this case is not significant, too.

5.Frame picture, M=3, with I-picture

source order	:	P1	B2	B3	P4	B5	B6	P7	B8	B9	I10	B11	B12	P13
[case7]														
coding order	:				P4	(B2)	B3	(P7)	(B5)	B6	I10	B8	B9	P13
reference#1		P1	----------								I10	----------		
reference#2		P-2	----------		P4	----------								P13

reference buffer is shown as frame buffer

[case7]

When B2,B5 and P7 become S-pictures, we can select P1 and P4 for the reference pictures of B3, and P4 as the sole reference picture of B6, respectively, from the analogy of case4. Of course, the selecting rule of reference pictures in the Frame picture should be modified as follows.

For the forward prediction mode, either of the latest decoded P-picture or I-picture which precedes the currently processed picture both in the source order and in the coding order, can be used as the reference picture. For the backward prediction mode, either of the latest decoded P-picture or I-picture which follows the currently processed picture in the source order and precedes it in the coding order, can be used as the reference picture, if it exists.