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Title: Syntax modification for compatibility/spatial scalability
Purpose: Proposal
Relevant Sub group: Video

1. Introduction

There are some problems in the current TM syntax of compatibility/spatial scalability such as a dummy motion vector in the spatial only prediction mode. A modified syntax has been made to correct the syntax. Computer simulation was carried out to investigate the effectiveness of this syntax modification.

2. Problems in the current compatibility/spatial scalability syntax

There are the following two problems in the current compatibility/spatial scalability syntax.

(1) Dummy motion vector in spatial only prediction

No motion vector is used in the spatial only prediction. Nevertheless, dummy motion vectors are coded in some combinations of prediction weights as pointed out in MPEG93/326 and MPEG93/365. 1) Dummy motion vectors have to be coded in a full spatial compatible macroblock in B-pictures because a full spatial compatible macroblock type does not exist in B-pictures. 2) Dummy motion vectors have to be coded when the picture structure is frame, temporal prediction is field based, and spatial prediction is used in one field.

(2) Wasted prediction_weight_code

Prediction weight is not used in a full spatial prediction macroblock. But in the current syntax, the prediction_weight_code is coded in all compatible macroblocks except in I-pictures.

3. Syntax modification

A new syntax for compatibility/spatial scalability is proposed to overcome the problems mentioned in section 2. This syntax is shown in Annex 1.

1) A new macroblock type is added for full spatial compatible macroblock in the B-picture. As a result of this modification, the combination of the prediction weights for full spatial

prediction (i. e. w1=1 for the field structure and w1=1, w2=1 for the frame structure) become unnecessary. Therefore, this combination is prohibited to be used.

2) A new flag "single_field_spatial_prediction" is added in the prediction weight table to show a spatial only prediction for one field in the frame structure. If this flag is 1, then a new frame_motion_type "single field-based prediction" is used instead of field-based prediction. Single field-based prediction means that temporal prediction is field based and spatial prediction is used in one field. The motion_vector_count in single field-based prediction is 1. Therefore, the dummy motion vector for the spatial only predicted field is not coded.

3) The macroblock layer is modified not to code the dummy prediction_weight_code in a full spatial prediction macroblock. The condition for coding the prediction_weight_code is modified not to code the prediction_weight_code for a full spatial compatible macroblock type.

4. Simulation

Computer simulations were carried out to investigate the effectiveness of the above-mentioned syntax modification. The conditions for the simulations were as follows.

Coding strategy

Base layer: MPEG1

Upper layer: TM2 base, Frame structure Frame/Field adaptive prediction

Coding rate

Base layer : 1.15 Mbps, Total : 4.0 Mbps

Sequence : Football (new), Flower garden 2 seconds

Motion vector search area

Base layer ±15 pels/frame (FB), ±7.5 pels/frame (FG)

Upper layer ±30 pels/frame (FB) ±15 pels/frame (FG)

Prediction weight (w1, w2)

Spatial only : (1,0), (0,1)

Spatio-temporal weighting 1 : (1,0), (0,1), (1,1), (0.5,0.5)

(default table in TM5 Appendix G)

A full spatial compatible macroblock was used instead of (1,1) after syntax modification

Spatio-temporal weighting 2 : (1,0), (0.75,0.25), (0.75,0.5), (0.5,0.5)

(default table in TM5 Chapter 9)

The SNR values and the percentages of the prediction weight selection are shown in Table 1 and 2, respectively.

The SNR values of the football sequence were improved about 0.4-0.5 dB in spatial only and spatio-temporal weighting 1 by the syntax modification. This was because the combination of the prediction weight =(1,0) and the field-based prediction, in which a dummy motion vector was needed before the syntax modification, was selected very often.

In spatio-temporal weighting 2, the improvement of the SNR value was 0.25 dB for the football sequence, which was smaller than those of spatial only and spatio-temporal weighting 1. This was because the percentage of the prediction weight =(1,0) was smaller than those of spatial only and spatio-temporal weighting 1.

The SNR improvement of spatio-temporal weighting 2 from spatial only was only 0.09 dB after syntax modification, while that before syntax modification was 0.38 dB. This was because more dummy motion vectors were coded in spatial only prediction than spatio-temporal weighting before syntax modification.

The results of the simulations are summarized that:

1) The syntax modification was effective especially in sequences with a high percentage of compatible mode and field-based prediction such as the football sequence.

2) The SNR difference between spatio-temporal weighting and spatial only became smaller after the syntax modification because the increase of motion vector information in spatio-temporal weighting was not taken into account in the old syntax.

5. Conclusion

Problems of the current compatibility/spatial scalability syntax were sorted out and pointed out. A syntax modification to overcome these problems was investigated. Computer simulations were carried out to investigate the effectiveness of this modification. The simulation results showed the effectiveness of such a modification.

We propose that this kind of modification should be introduced in the current compatibility/spatial scalability syntax.

Table 1 Simulation results on syntax modification : SNR values

Football

	SNR (I: P : B)	
	before syntax modification	after syntax modification
spatial only	34.94 (35.37:35.14:34.83)	35.46 (36.00:35.99:35.21)
spatio-temporal 1	35.10 (35.53:35.42:34.94)	35.52 (36.02:36.13:35.26)
spatio-temporal 2	35.32 (35.68:35.83:35.10)	35.55 (36.03:36.16:35.29)

Flower garden

	SNR (I: P : B)	
	before syntax modification	after syntax modification
spatial only	28.84 (28.76:28.77:28.88)	28.96 (28.89:28.89:28.99)
spatio-temporal 1	28.91 (28.82:28.87:28.93)	29.00 (28.91:28.97:29.02)
spatio-temporal 2	29.02 (28.92:29.08:29.01)	29.06 (28.96:29.12:29.04)

Table 2 Simulation results on syntax modification : percentage of each prediction weight

Football

	percentage(%)					
prediction weight :	(1,1)	(0,1)	(1,0)	(0.5,0.5)	(0.75,0.25)	(0.75,0.5)
spatial only (before syntax modification)						
Ppic	9.76	66.30	0.73	-	-	-
Bpic	0.56	45.01	0.54	-	-	-
spatial only (after syntax modification)						
Ppic	14.27	61.35	0.60	-	-	-
Bpic	0.83	39.09	0.43	-	-	-
spatio-temporal 1 (before syntax modification)						
Ppic	5.18	50.80	0.07	24.84	-	-
Bpic	0.20	39.39	0.20	7.76	-	-
spatio-temporal 1 (after syntax modification)						
Ppic	10.19	47.08	0.05	23.76	-	-
Bpic	0.54	35.26	0.19	6.88	-	-
spatio-temporal 2 (before syntax modification)						
Ppic	8.35	27.57	-	6.90	31.19	10.01
Bpic	0.47	29.46	-	2.88	13.33	1.65
spatio-temporal 2 (after syntax modification)						
Ppic	8.13	27.67	-	7.02	31.31	9.25
Bpic	0.43	27.57	-	2.80	12.77	1.45

Flower Garden

	percentage(%)					
prediction weight :	(1,1)	(0,1)	(1,0)	(0.5,0.5)	(0.75,0.25)	(0.75,0.5)
spatial only (before syntax modification)						
Ppic	6.66	43.93	1.16	-	-	-
Bpic	0.95	13.02	0.90	-	-	-
spatial only (after syntax modification)						
Ppic	7.43	42.78	1.03	-	-	-
Bpic	1.01	12.64	0.87	-	-	-
spatio-temporal 1 (before syntax modification)						
Ppic	4.45	36.44	0.55	15.9	-	-
Bpic	0.61	11.67	0.69	3.00	-	-
spatio-temporal 1 (after syntax modification)						
Ppic	5.29	35.90	0.50	15.27	-	-
Bpic	0.71	11.36	0.68	2.98	-	-
spatio-temporal 2 (before syntax modification)						
Ppic	3.86	17.88	-	5.29	28.90	4.67
Bpic	0.69	8.40	-	1.61	4.37	1.23
spatio-temporal 2 (after syntax modification)						
Ppic	3.86	17.87	-	5.31	28.69	4.64
Bpic	0.69	8.32	-	1.61	4.36	1.22

Annex 1 Modified syntax

Table B.2c3. Variable length codes of macroblock_type in bidirectionally predictive-coded pictures (B-pictures).

Following entries are added.

VLC code	macroblock_ quant	macroblock_ motion_ forward	macroblock_ motion_ backward	macroblock_ pattern	macroblock_ intra	macroblock_ compatible
| 00000010	0	0	0	1	0	1
| 00000011	1	0	0	1	0	1

NOTE The VLC codes in this table are just one example.

prediction_weight_code

The prediction_weight_code for full spatial prediction in a macroblock (i.e. w1=1 in the field structure and w1=1, w2=1 in the frame structure) is not allowed.

prediction_weight_code	Field 1 weight w1	Field 2 weight w2	single_field_spatial_predictio
| 00	1	0	1
| 01	0	1	1
| 10	reserved		
| 11	0.5	0.5	0

NOTE: This table is an example of the default prediction weight **Table G.1.** Full spatial prediction for field 1 and field 2 (prediction_weight_code=="10") is deleted from the table because it should be defined in a compatible macroblock type as pointed out in MPEG93/326.

single_field_spatial_prediction - This is NOT a syntax element. If picture_structure=="frame", single_field_spatial_prediction is set to "1" in case of spatial only prediction for Field 1 or Field 2 only (i.e. (Field 1 weight w1==1&&Field 2 weight w2!=1) || (Field 1 weight w1!=1&&Field 2 weight w2==1). If picture_structure =="field" or compatible_mtype is neither "01" nor "11" then single_field_spatial_prediction is set to 0.

frame_motion_type

code	prediction type	motion_vector_count	mv_format	dmv
00	Single field-based prediction	1	field	0
01	Field-based prediction	2	field	0
10	Frame-based prediction	1	frame	0
11	Dual-Prime	1	field	1

If single_field_spatial_prediction==1 then frame_motion_type will be changed to "Single field-based prediction" from "Field-based prediction".

Spatial Macroblock Layer

```
macroblock(){
    if ( <sequence extension was not present> )
        while (nextbits()=='0000 0001 111')
            macroblock_stuffing                                  11    vlclbf
    while (nextbits()=='0000 0001 000')
        macroblock_escape                                        11    vlclbf
    macroblock_address_increment                                 1-11  vlclbf
    macroblock_type                                              1-8   vlclbf
    if ( macroblock_compatible &&
        ( macroblock_motion_forward
         || macroblock_motion_backward ) &&
            compatible mtype != '10' )
        prediction_weight_code
    if (macroblock_motion_forward ||
            macroblock_motion_backward ) {
        if (picture_structure== 'frame' ) {
            if ( frame_pred_frame_dct == 0 )
                frame_motion_type                                2     uimsbf
        } else {
            field_motion_type                                    2     uimsbf
        }
    }
    if ( ( picture_structure == 'frame' ) &&
            ( frame_pred_frame_dct == 0 ) &&
                ( macroblock_intra || macroblock_pattern ) )
        dct_type                                                 1     uimsbf
    if(macroblock_quant)
        quantizer_scale                                          5     uimsbf
    if(macroblock_motion_forward ||
            ( macroblock_intra && concealment_motion_vectors ) )
```



```
        forward_motion_vectors()                                 ...   ...
    if(macroblock_motion_backward)
        backward_motion_vectors()                                ...   ...
    if( macroblock_intra && concealment_motion_vectors )
        marker_bit                                               1
    if(macroblock_pattern)
        coded_block_pattern()
    if ( !chroma_scalable ) {
        block_count_start = 0;
        block_count_end = block_count;
    } else {
        block_count_start = 4;
        if ( chroma_format = 4:2:2 ) {
            block_count_end = 8;
        } else if ( chroma_format = 4:4:4 ) {
            block_count_end = 12;
        }
    }
    for (i=block_count_start; i<block_count_end; i++) {
        if( compatible_mtype == "10" && !macroblock_pattern ) {
            snr_block(i)
        } else{
            block(i)
        }
    }
    if (picture_coding_type==4)
        end_of_macroblock                                        1     "1"
}
```