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SOURCE : Japan
TITLE : VBV operation in 3:2 pulldown
PURPOSE : Proposal
Relevant sub-group: Video

1.Introduction

3:2 pulldown can be performed in MP@ML to display 24Hz or 23.976Hz film source (Refer to MPEG93/089). This contribution clarifies VBV operation taking into account of the 3:2 pulldown, and considers lowdelay operation in the 3:2 pulldown mode.

2.Encoding operation in 3:2 pulldown

To perform 3:2 pulldown, an encoder should set **non_interlaced_sequence** to 0, **picture_structure** to 11(Frame-Picture) and **number_of_field_display_code** to 0 or 1. The **number_of_field_display_code**, in a picture header, implies displaying duration of the picture. If it is equal to 1, the picture must be displayed during a 3-field duration. If it is equal to 0, the picture must be displayed during a 2-field duration.

3.VBV operation taking into account of 3:2 pulldown

VBV attempts to remove the buffer contents at every period t. The value of t should be defined as follows.

$$t = \frac{1}{\text{field\_per\_picture} * P} * \text{field\_count}$$

where: -field_per_picture = 2, if **picture_structure** is Frame.
= 1, if **picture_structure** is not Frame.
(in case of 3:2 pulldown mode, this value is always equal to 2.)
-P is the number of pictures per second calculated from the **picture_rate**.
-field_count = 2, if **number_of_field_display_code** is 0.
= 3, if **number_of_field_display_code** is 1.

Immediately after the VBV removes the buffer contents, the next period t can be calculated in the following two ways.

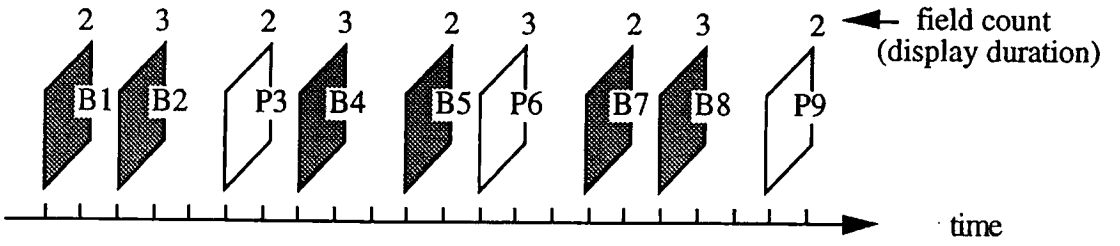
1) The value of t is calculated using the **number_of_field_display_code** in the picture header of the last picture removed from the buffer.
2) The value of t is calculated using the **number_of_field_display_code** in the picture header of the picture to be removed from the buffer.

In case of M=1, the decoded picture can be instantaneously displayed, so that decoding can be synchronized with the displaying. Hence **number_of_field_display_code** in a picture header is regarded as the interval before starting to decode the next picture. Therefore it is appropriate to calculate the value of t in the way of 1). Then we can define the period t for VBV operation as follows.

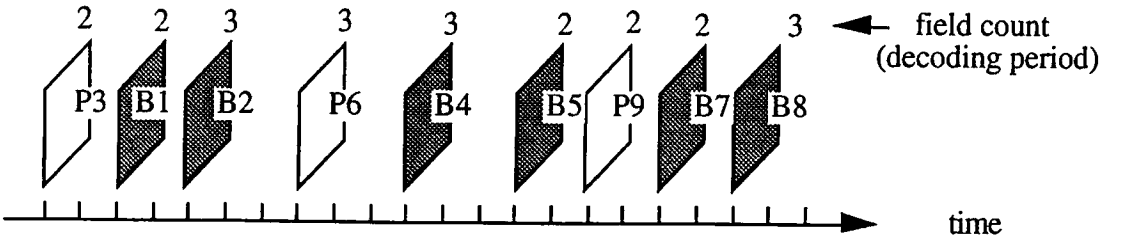
'The period of time, t, is specified by the **picture_rate** in the sequence header and the **picture_structure** and the **number_of_field_display_code** in the picture header of the last picture removed from the buffer. '

In case of M>1, it is noted that the source order is not equal to the coding order, that is, the 'field count' sequence in the source order is different from the one in the coding order. Assuming that M=3 for example, this relation is shown as;

Source order

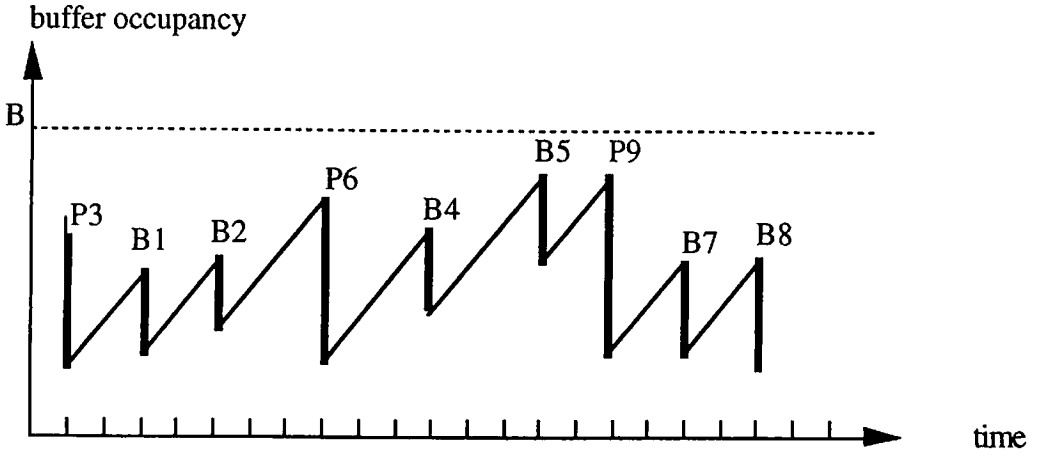


Coding order



Also, in the case of M=3, the transition of VBV buffer occupancy is depicted as;

Transition of VBV buffer occupancy



In this case, VBV removes the buffer contents for each irregular period. Therefore an encoder must control the coding operation carefully not to cause VBV violation.

4.3:2 pulldown and lowdelay coding

In the case when picture skipping due to encoding 'large picture' takes place, VBV can not remove the complete picture data from the buffer. Therefore the VBV defers the data removal by the next timing. If the VBV could not remove the complete picture data from the buffer in the 3:2 pulldown mode, it should calculate the time period t for the next removal as;

1) The VBV calculates the value of t using the **number_of_field_display_code** in the picture header of the last picture removed from the buffer.
2) The VBV calculates the value of t using the **number_of_field_display_code** in the picture header of the picture to be removed from the buffer.
3) The VBV presumes the value of t appropriately.

In any case, after the picture skipping takes place, the encoding timing may differ from the data removal timing of the VBV. It implies that the VBV violation may be caused. Hence picture skipping must not take place in the 3:2 pulldown mode. Furthermore we do not need the lowdelay operation, which allows picture skipping, in the 3:2 pulldown mode.

5.Proposal

According to these considerations on the 3:2 pulldown mode, we propose that;

-Taking into account of 3:2 pulldown mode, the period t for VBV operation should be defined that 'The period of time, t, is specified by the **picture_rate** in the sequence header and the **picture_structure** and the **number_of_field_display_code** in the picture header of the last picture removed from the buffer. '

-In case of 3:2 pulldown mode and M>1, an encoder must control the coding operation carefully not to cause VBV violation.

-Picture skipping must not take place in the 3:2 pulldown mode. Furthermore we do not need the lowdelay operation, which allows picture skipping, in the 3:2 pulldown mode.

END