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Title: Experiments on increased error resilience by transmitting I-frame motion vectors

Purpose: Information and discussion

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1. Introduction:

This contribution describes some experimental results on increased resilience by transmitting I-frame motion vectors. Certain coding applications face a very noisy channel, such as ATM or terrestrial broadcast, where error resilience is mandatory for acceptable quality. This document proposes a syntax change to aid concealment in intra frames, where errors have an impact that last until the following intra frame. Current error concealment strategies for I frame losses include temporal substitute with co-located data in the previously decoded anchor frame and spatial interpolation with data in the surrounding neighbors. The former cuases large errors in the moving areas and the later causes blurring in the active areas. The proposed method alleviate the problem at the expense of transmitting the redundancy of I-frame motion information.

2. Description:

Motion information is very useful in concealing losses in P and B frames, but is not available for I frames. This limits the concealment algorithm to spatial or simple temporal methods, which are not always succesful. Therefore, we propose a syntax extension where motion vectors can be transmitted in an I frame fro error concealment purpose. The following table defines intra macroblock types for which a motion vector can be sent.

The macroblock syntax is unchanged, however the motion vectors are interpreted in the following way:

The decoded forward motion vectors belong to the macroblock spatially below the current macroblock, and describe how that macroblock can be replaced from the previous anchor frame in the event that the macroblock cannot be recovered.

VLD Code	macroblock quant	macroblock motion forward	macroblock motion backward	macroblock pattern	macroblock intra
1	0	0	0	0	1
01	1	0	0	0	1
001	0	0	0	0	0
0001	0	1	0	0	1
00001	1	1	0	0	1

Table 1: Macro-block coding type for I-frame concealment motion vectors

3. Simulation Results:

Two sequences: Mobi and Bus have been used for simulations. The experimental results for different slice sizes are given in Table 2 and 3 for Mobi and Bus, respectively. In document MPEG93/107, error performance versus slice size is shown in conjuction with structured packing. For comparision with I-frame motion vectors, we used slice size of 11 which was a good compromise between overhead and concealment ability.

Several concealment strategies are compared in Table 2 and 3 for Mobi and Bus sequences (frame 15-150), respectively, with bitrate of 4 Mbps, N=15, M=3, slice size of 11 and cell loss rate (CLR) of 10^{-2}. Since the first GOP has not past data for the first I-frame, the results start at frame 15.

Method	SNR (dB)	
	No loss	CLR of 10^{-2}
Temporal replacement	28.28	23.70
Adaptive spatiotemporal	28.28	23.41
I motion vectors	28.25	26.47

Table 2. Mobi (frames 15-150)

Method	SNR (dB)	
	No loss	CLR of 10^{-2}
Temporal replacement	30.79	25.19
Adaptive spatiotemporal	30.79	25.67
I motion vectors	30.75	26.84

Table 3. Bus (frame 15-150)

Temporal replacement means replacement with the corresponding MB in the previous I or p picture with field or frame motion vectors from the top MB. The adaptive concealment algorithm uses spatial and temporal replacement with a sophisticated decision mechanism, the motion vectors used in the experiment are from the top MB in frame mode only. The results have shown that the method using I frame motion at CLR of 10^{-2} outperforms the others at the expense of small overhead at no error case which only causes about 0.03-0.4 dB quality degradation.

A D-1 tape demonstrates the experimental results. The tape contents are as follows (all with M=3, N=15):

1. Mobi coded with temporal replacement at N=15, M=3 and bitrate of 4 Mbps, frames 15-150 at cell loss rates of 10^{-2}.

2. Mobi coded with I frame motion vectors at N=15, M=3 and bitrate of 4 Mbps, frames 15-150 at cell loss rates of 10^{-2}.

3. Bus coded with temporal replacement at N=15, M=3 and bitrate of 4 Mbps, frames 15-150 at cell loss rates of 10^{-2}.

4. Bus coded with I frame motion vectors at N=15, M=3 and bitrate of 4 Mbps, frames 15-150 at cell loss rates of 10^{-2}.

4. Conclusions:

The proposed syntax change about I frame motion vectors enables simple yet effective error concealment without impacting system features such as random access and bitstream editing via I frames. The overhead used for transmitting I frame motion vectors is less than 0.7% of the total bitstream or equivalent to the 0.3-0.4 dB quality degradation on the bitrate of 4 Mbps.

In the cases of relative higher cell loss rates, the coding method with transmission of I frame motion vectors provide the better results than other error concealment methods which are with decoder option only. For Mobi, the gain was 3.06 dB and for Bus it was 1.17 dB better than a sophisticated adaptive spatial/temporal method. The corresponding gains over simple temproal replacement were 2.77 dB and 1.65 dB respectively.