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Title : Cell loss experiments in layered coding
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Purpose : Information

1 Introduction

Layered coding is a well-known technique to achieve compatibility with existing standards. Compatibility is reached by generation of an MPEG1 bitstream and an additional bitstream which can be used to obtain improved picture quality. In Test Model 2 of MPEG2, this technique is also adopted to achieve compatibility with MPEG1. However, layered coding can also be used to achieve a high level of ATM cell loss resilience. In this document, concealment techniques for a field structured picture coding scheme are introduced. It is investigated how these techniques influence the performance of this coding scheme when it is subject to cell loss.

2 Description of the implemented coding scheme

The implemented MPEG Test Model 2 [1] codec is a field structured picture based codec: the pictures are processed field per field and the predictions are only field based predictions. The temporal predictions for the odd fields are only taken from previous odd fields, the temporal predictions for the even fields are taken from previous odd as well as previous even fields.

To achieve MPEG1 compatibility, the source CCIR 601 pictures are downsampled to SIF as described in the Test Model. These SIF pictures are coded with an MPEG1 coder. The reconstructed MPEG1 pictures are upsampled and used as a spatial prediction for the odd fields in the MPEG2 codec. In the MPEG2 codec, it is decided on a macroblock basis whether a temporal, a spatial or a combination of a temporal and a spatial prediction is used for the odd fields.

3 Concealment techniques

3.1 Introduction

A well known concealment technique in two-layered coding is using the MPEG1 pictures as a fall back mode for the MPEG2 pictures. This is a very robust technique when the MPEG1 information is sent over a guaranteed channel or when the cell loss priority bit is always set for the MPEG1 information. However, with this technique the MPEG2 resolution can not be reached. For the odd fields some spatial resolution is lost. For the even fields even no MPEG1 pictures are available when pure field coding is adapted. When for even fields the last decoded MPEG1 picture is used, a loss in spatial *and* temporal resolution will occur, which can lead to annoying artefacts. So, it was investigated how the MPEG1 information can be combined with a reconstruction on basis of previous decoded full resolution (MPEG2) pictures.

3.2 Error concealment for odd fields

The procedure when cell loss occurs in odd field information of the enhancement layer is as follows:

1. Skip the MPEG2 data until a new slice start code is found;
2. Use the MPEG1 vectors to get (full resolution) temporal predictions for all macroblocks between the last fully decoded before cell loss and the first to be decoded after resynchronization;
3. Use the same macroblock type as the corresponding MPEG1 macroblock;
4. Add the corresponding (upsampled) MPEG1 prediction error to the predictions;
5. Start normal MPEG2 decoding again when a new start code is found.

Note that, as one MPEG1 macroblock corresponds to two MPEG2 macroblocks, the vector and the macroblock type of each MPEG1 macroblock are used for the reconstruction of two MPEG2 macroblocks. At this moment, no spatial prediction from the MPEG1 frame memories is used in case of cell loss.

3.3 Error concealment for even fields

When cell loss occurs during transmission of the even field information, it is not possible to use the MPEG1-information directly as done for the odd fields. The MPEG1 vectors and macroblock types of a certain picture is decoded during decoding the odd field, and is not available anymore during the decoding of the even field of that picture. This is due to the adopted field structured picture coding; for frame coding, this problem does not exist.

To overcome this problem, the decoded MPEG1 vectors are saved in the decoder. Two MPEG1 vector fields are needed (forward and backward). When a forward or a backward vector is not used for the MPEG1 picture, a special code is saved instead. In this way, the MPEG1 vector field can be used to get an indication of the MPEG1 macroblock types during even field decoding. The procedure when cell loss occurs in even field information of the enhancement layer is now as follows:

1. Skip the MPEG2 data until a new slice start code is found;
2. Choose a macroblock type using the saved MPEG1 vector fields;
3. Use the saved MPEG1 vectors to get (full resolution) temporal predictions for all macroblocks between the last fully decoded before cell loss and the first to be decoded after resynchronization;
4. Start normal MPEG2 decoding again when a new start code is found.

The prediction is taken from the odd or even field memory with the minimum time distance from the actual even field. The MPEG1 prediction error is not used, as this is only available during decoding the odd fields. Starting from the MPEG1 vectors, the calculation of the full resolution vectors consists of three steps: a correction for the difference in spatial resolution, a correction for the difference in time distance between original and prediction and a halfpel correction in vertical direction when the prediction for the even field is taken from an odd field memory.

4 Experiments

The sequences Calendar, Table Tennis and Susie were coded with a total bitrate of 4 Mbit/s. A bitrate of 1.5 Mbit/s was used for the base (MPEG1) layer, the remaining 2.5 Mbit/s were used for the enhancement layer. Coding parameters used are: $M = 3$, $N = 12$. No adaptations in the encoder are made to make the bitstream more resilient to cell loss.

The packetization and the simulation of cell loss used are described in [2]. The base layer information was transmitted in high priority cells, all enhancement layer information however was transmitted in low priority cells. Cell loss was only simulated for the low priority cells. An overall (= low + high priority) cell loss ratio of $1.0 * 10^{-3}$ and a mean burst of length of 4 were used.

Each bitstream is decoded twice:

1. With use of the concealment techniques described in the previous paragraph;
2. Without use of these concealment techniques; reconstructions are made by just repeating parts of the previous field of the same parity.

Without use of the concealment techniques, the picture quality is not acceptable. Especially the large differences between the odd and even fields caused by cell loss lead to very annoying (high frequency) artefacts. When the concealment techniques are used, the picture quality is almost the same as the picture quality when no cell loss occurs.

An accompanying tape is produced to subjectively verify the results.

5 Conclusions

The cell loss resilience of a two layered MPEG2 pure field coding scheme was investigated. Concealment techniques based on the full resolution frame memories instead of the MPEG1 frame memories were introduced. It was shown that with these techniques a high level of cell loss resilience can be reached.

Further work must be done to investigate the cell loss resilience of layered coding for low delay modes.

6 References

- [1] ISO-IEC/JTC1/SC29/WG11 MPEG92/N0245, MPEG Test Model 2.
- [2] CCITT SGXV, WP XV/1, AVC-205, Cell loss experiment specifications.

7 Acknowledgement

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