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TITLE: Compatible coding of CCIR 601 images:
Predict the prediction error

PURPOSE: Information

Abstract

In document AVC-33, a set up of a multi purpose coding scheme for CCIR 601 video signals was presented. With this scheme, upward and downward compatibility was reached with H.261 or MPEG1. For compatibility, the prediction for the odd fields was based on SIF frames. The conversion from CCIR 601 odd fields to SIF is made in the transform domain.

In this paper, a modification of the proposed scheme is described.
A second DPCM loop, operating on CCIR 601 resolution, was added. In this way, two prediction error signals are computed: one based on a SIF prediction and one based on a CCIR 601 prediction.

First, the SIF prediction error signal is transformed and quantised, resulting in a compatible bitstream. This quantised signal is used as a prediction for the second prediction error signal, based on a CCIR 601 prediction.

One of the main advantages of this scheme is the possibility to have a full resolution prediction without losing compatibility. Furthermore, the decoder for the odd fields can be kept very simple: only a CCIR 601 DPCM-loop is needed, not a SIF DPCM-loop in addition.

An accompanying D1 tape is produced to verify both the full CCIR 601 resolution and SIF resolution results (according to MPEG1). Results are obtained in cooperation with Laboratoires d'Electronique Philips, France.

1. Introduction

In document AVC-33, a set up of a multi purpose coding scheme for CCIR 601 video signals was presented. With this scheme, full compatibility was reached with H.261 or MPEG1, with relatively small increase in hardware complexity.

For compatibility, the prediction for the odd fields was based on SIF frames. Compatibility was achieved by encoding the full resolution signal after transformation with a 16*8 DCT for luminance and a 16*16 DCT for chrominance. To construct the SIF image, an inverse 8*8 DCT was used. In this way, an implicit CCIR 601 to SIF conversion in the transform domain was applied.

The even fields are not used for the compatible bitstream, so prediction for these fields can be made on the entire field. The prediction can be taken from odd as well as even fields.

With this scheme, promising results were reached. However, many modules in this scheme were subject to further study. It was expected that better results would be reached when also the additional resolution part of the odd fields was predicted. In this paper, a modification of the scheme is proposed which makes full resolution prediction possible without losing compatibility.

2. Predict the prediction error

In figure 1 the scheme is given of the odd field encoder, including the proposed modification. The basic idea of this scheme is as follows:

Two prediction error signals are computed: one based on a SIF prediction and one based on a CCIR 601 prediction. First, the SIF prediction error signal is transformed and quantised (in the inner loop, figure 1) resulting in a compatible bitstream. Next, the quantised prediction error of the inner loop is used as a prediction for the prediction error signal of the outer loop.

The weighting filter W_fs is used to suppress the annoying ringing effects in the compatible image caused by the implicit conversion from CCIR 601 to SIF. The prediction module is implemented as a simulcast/no simulcast switch for 16*8 blocks.

One of the main advantages of this scheme is the possibility to have a full resolution prediction without losing compatibility. Furthermore, the decoder for the odd fields can be kept very simple: only a CCIR 601 loop is needed, not a SIF loop in addition. The odd field decoder is shown in figure 2.

Another interesting point is that with this scheme it is extremely simple to switch to simulcast for a whole sequence or to switch the compatible loop off when compatibility is not required.

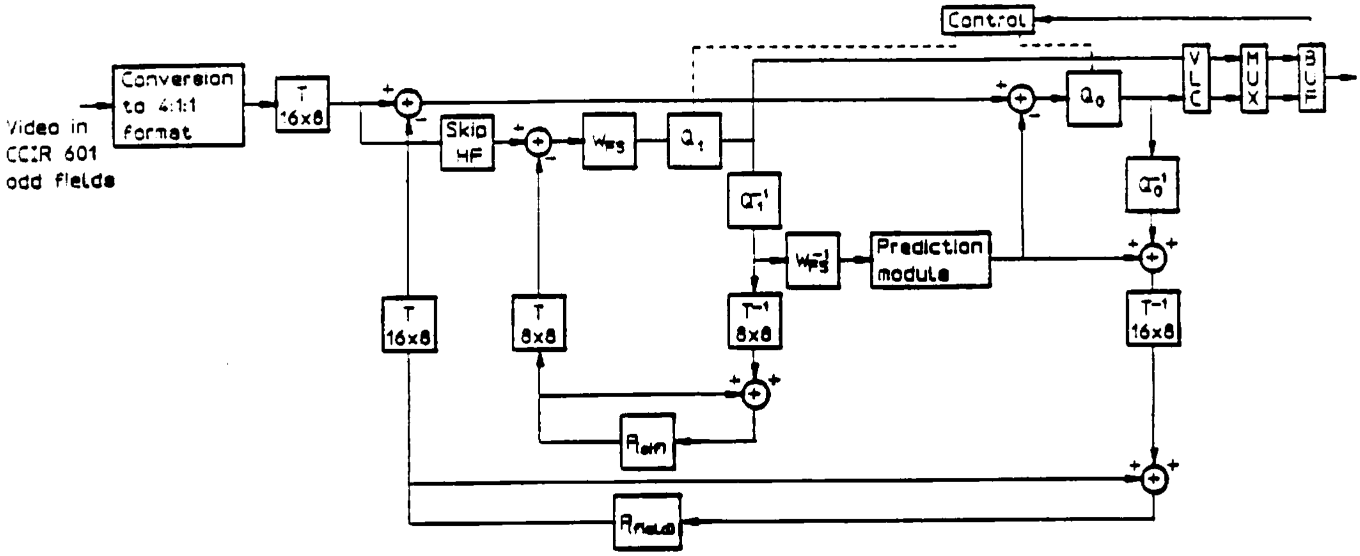

Figure 1. Odd field encoder. The quantised prediction error of the inner loop is used as a prediction for the prediction error of the outer loop.

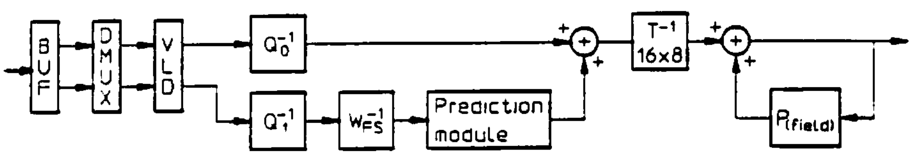

Figure 2. Odd field decoder; no SIF loop is required.

3. Simulation results

Results will be shown of an implementation of the proposed scheme which:

- creates a bitstream for the compatible SIF image using the MPEG1 syntax;
- operates on CCIR 601 converted to the 4:2:0 format;
- produces one intra frame out of 10 (N = 10);
- interpolates one frame out of two (M = 2);
- creates 9 Mbit/s (2½ Mbit/s of this for the compatible bitstream).

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Characteristics of the implemented scheme:

SIF loop:

- processing on blocks of 8*8;
- motion compensation on half pel accuracy for SIF resolution for 16*16 blocks;
- mode decision for the SIF loop according to the mode decision of the full resolution loop.

Odd fields:

- SIF and CCIR 601 prediction;
- processing on blocks of 16*8 (=> 8*8 after conversion to SIF);
- motion compensation on half pel accuracy for CCIR 601 resolution for 16*8 blocks;
- no weighting filter W_fs is included;
- the prediction module is only an on/off switch.

Even fields:

- prediction on basis of the previous even field or symmetrical interpolation from the neighbouring odd fields;
- processing on blocks of 8*8;
- motion compensation on half pel accuracy for 16*16 blocks;
- no intra even fields; directly after an intra odd field, the prediction is only taken from the neighbouring odd fields, not from the previous even field.

In table 1, results are given for Calendar and Flower garden.
An accompanying D1 tape is produced to verify both the full CCIR 601 resolution and SIF resolution results.

SEQUENCE	Y	U	V
calendar (odd)	32.25	33.99	36.28
calendar (even)	32.07	32.71	35.01
flower garden (odd)	33.77	33.23	36.76
flower garden (even)	32.96	33.03	36.50

Table 1. SNR for Calendar and Flower garden (9 Mbits/s).