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SOURCE : PTT Research, the Netherlands

TITLE : Set up of CCIR 601 multi-purpose coding scheme

Purpose: Information

Abstract

The set op of a multi purpose coding scheme (MUPCOS) for CCITT 601 video signals is presented.

This MUPCOS features compatibility with H.261 on hardware level, as the same encoder can produce a MUPCOS bit stream or an H.261 bitstream. The MUPCOS features compatibility with MPEG on video-multiplex level, as the MPEG bitstream is part of the MUPCOS bitstream.

Several aspects for discussion and further study are pointed out.

The compatibility implies only a small decrease in coding efficiency and a small increase in hardware complexity. Therefore we support inclusion of this compatibility in the future coding standards for CCIR 601 resolution video signals.

An accompanying D1 tape is produced to verify of both the full CCIR 601 resolution and CIF resolution simulation results.

Introduction

CCITT rec. H.261 will be the standard for video coding at p x 64 kbit/s (p = 1..30), mainly for conversational services. It supports the CIF (Common Intermediate Format) and the QCIF picture formats (Quarter CIF), as given in table 1. Optionally, frame rate reduction can be applied (e.g. 10 Hz at 64 kbit/s).

ISO-MPEG is finalizing a standard for videocoding at bitrates around 1-2 Mbit/s, mainly aiming at storage applications. This standard could support many picture-formats, but at the moment only the SIF's (Source Input Formats, SIF625 and SIF525) as given in table 1 are considered. These allow for a simple conversion to the corresponding CCIR 601 picture formats.

The ISO-MPEG decoder as such is not able to decode an H.261 bitstream, but this can be realized with a small extension of this decoder. An H.261 decoder is not able to decode an MPEG bitstream unless the MPEG encoder operates in H.261 mode. However, this is not attractive for storage applications.

	CCIR601 625/50	SIF625	CIF	QCIF	SIF525	CCIR601 525/60
Number of act. pels/line Lumin. (Y) Chrom. (U,V)	720 360	360 180	360 180	180 90	360 180	720 360
Number of act. lines/picture Lumin. (Y) Chrom. (U,V)	576 576	288 144	288 144	144 72	240 120	480 480
Vertical interlacing	2:1	1:1	1:1	1:1	[illegible]	2:1
Field rate(Hz)	50	25	30	30	30	60
Frame aspect ratio	4:3					

Table 1 Considered picture formats.

The MUlti-Purpose COding Scheme (MUPCOS) proposed here, operates on full CCIR 601 formats. Bitrates must be in the range 2 - 10 Mbit/s. It may be used for following services and applications:

- conversational services (short encoding delay is required)
- distributive services (encoding delay is less important)
- storage applications (possibility of trick modes is important)

Depending on the application, the pictures are encoded in one of several modes, all included in the MUPCOS. MUPCOS implementations may support one or several of these modes.

The MUPCOS should be compatible with the H.261 and MPEG systems. Compatibility here means for the MUPCOS decoder that it should be able to decode a MUPCOS bitstream, an MPEG bitstream as well as an H.261 bitstream.
For the encoder, compatibility here refers to the following:

- Conversational services

  The MUPCOS encoder should be able to produce a MUPCOS bitstream as well as an H.261 bitstream. Depending on the type of decoder one of these bitstreams is produced. At the call set up the sender can identify the type of receiver: in case of an H.261 decoder an H.261 bitstream for CIF or QCIF will be sent, in case of a MUPCOS decoder a MUPCOS bitstream will be sent.

- Distributive services and storage applications

  The MUPCOS encoder should enable decoding by both MPEG and MUPCOS decoders. The sender cannot identify the receiver type, so it should supply in parallel an MPEG bitstream in one channel and a supplementary bitstream for the MUPCOS decoder in a second channel.

  For MPEG, bitrates are in the range of 1 - 2 Mbit/s, whereas for the MUPCOS bitrates are assumed in the range from 2 to 10 Mbit/s.

  A straightforward approach to compatibility would be to generate independantly the MPEG bitstream and the MUPCOS bitstream for CCIR 601, and store or transmit both. In case of a playback system with MPEG decoder, only the MPEG channel is decoded. In case of a MUPCOS decoder only the MUPCOS channel is decoded.

  In this case the MUPCOS algorithm can be optimized independantly from the MPEG standard, but it is evident that a more efficient use of the medium can be obtained if the second channel only carries information which is additional to the first channel. The information of the second channel together with the MPEG bitstream in the first channel then provides the information for the MUPCOS decoder. Now the MUPCOS algorithm can not be optimized independantly of the MPEG standard, but a more efficient use of the medium results.

Compatibility in picture formats

In the encoder: In practice, the SIF formats can be obtained from their corresponding CCIR 601 formats by simple processing: from CCIR 601 the odd fields are extracted. After appropriate horizontal lowpass filtering, the luminance component is horizontally decimated 2:1. The chrominance components are decimated 2:1 in horizontal and vertical directions, after horizontal and vertical filtering.

Conversion of CCIR 601 to CIF requires either a framerate conversion for the 625/50 format or a conversion in the number of lines per picture for the 525/60 format. When a CCIR 601 camera is used, this conversion is only needed when the receiver has a H.261 decoder.

Allthough skipping the even fields is a very practical way to convert a CCIR 601 format to the corresponding SIF format, in theory a vertical-temporal lowpass filtering would be required before this decimation.

Figure 1 shows the Nyquist region of a 625/50 interlaced signal in the vertical-temporal frequency plane. The Nyquist region of the SIF25 signal is rectangular in this frequency plane. The vertical-temporal lowpass filter should bandlimit the CCIR 601 signal to the SIF Nyquist region.

In the decoder: CIF, SIF25, SIF30, and both CCIR 601 formats can be displayed on a multiscan monitor. CIF, SIF25 and SIF30 can be expanded to a larger number of lines and/or pels per line by oversampling and interpolation. A higher framerate can be obtained by frame repetition.

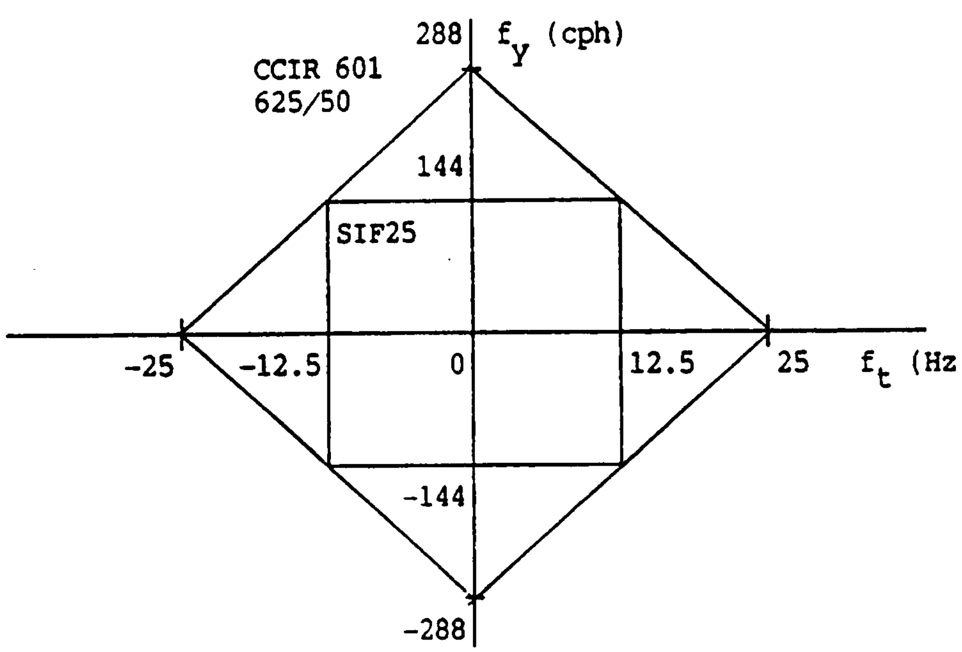

Figure 1 Nyquist regions in f_y, f_t plane

Design philosophy of MUPCOS

In theory a vertical-temporal prefiltered SIF signal (as drawn in figure 1 for SIF25) with 360 pels per line should be transmitted as MPEG bitstream in the base channel. The supplementary information to obtain CCIR 601 is transmitted in the second channel. In addition to information for additional spatiotemporal resolution, the second channel may also carry information for additional quantization accuracy of the SIF signal.

In practice, the odd fields of the CCIR 601 signal are horizontally decimated and transmitted in the MPEG channel. The additional horizontal resolution and quantization accuracy for the odd fields as well as the additional information for the even fields are transmitted in the second channel.

A bitrate of 2 Mbit/s for the MPEG bitstream and a bitrate of 0 to 8 Mbit/s for the second channel are assumed. Now the research problem is how to allocate the bits of the second channel to:

- additional quantization accuracy of the odd fields
- additional resolution of the odd fields
- additional temporal or vertical resolution by sending additional information, enabling a better reconstruction of the even fields than reconstruction based on the odd fields only.

MPEG basic encoder

Drafting of the compatible encoder structure started with the MPEG basic encoder as shown in figure 2. Here, the conversion from CCIR 601 to SIF is performed by a preprocessing unit. The video signal is processed in blocks of 8x8 pixels. Each prediction error block is transformed by an 8x8 discrete cosine transform (DCT).

To reduce the overhead, mode decisions and motion vectors are transmitted only for macroblocks. For SIF, a macroblock consists of 4 luminance blocks and one block of each colour difference picture, as illustrated in figure 3.

REMARK:

In the coding schemes the VLC blocks represent the variable length coding and the video multiplex.

The BUF blocks represent the buffer of the video bitstream. The buffer fullness is the input for the buffer control, represented with the feed-back line.

The MUX blocks represent the channel multiplex and channel adaptation, not the video multiplex.

MPEG basic encoder

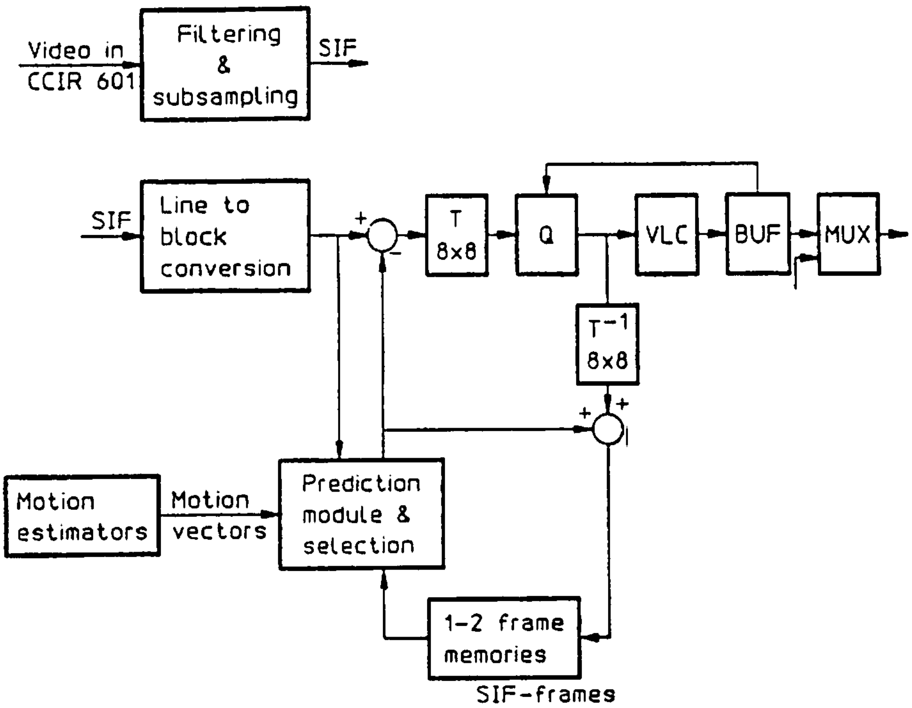

Figure 2 MPEG basic encoder

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Macro blocks in a SIF picture

* Size of macroblock : 16x16 pixels for luminance (Y)
  16x8 pixels for chrominance (C)

* Blocks in a macroblock :

Y :

Y_1	Y_2
Y_3	Y_4

Blocksize 8x8

C :

C_b	C_r

Blocksize 8x8

Figure 3 Macro blocks in a SIF picture

MPEG compatible encoding of the odd fields

As the compatible SIF pictures are obtained from the odd CCIR 601 fields, an odd field encoder as depicted in figure 4 is proposed, which is SIF compatible. Complete odd fields are encoded, but the temporal DPCM loop here operates with SIF format for compatibility.

The format conversion from CCIR 601 odd fields to SIF is obtained in the transform domain. As the SIF decoder has a size 8 x 8 inverse DCT, the following DCT sizes are required for the odd field encoder:

- 16 x 8 for luminance
- 16 x 16 for both colour difference components

The performance of the field to SIF decimation in the transform domain is sufficient for SIF applications.

Employment of 16x16, 16x8 and 8x8 DCT's in the same encoder may seem unattractive for implementation. However, we claim that efficient implementations of the 16x16 DCT exist that are able to perform a 16x8 and 8x8 DCT as well. For the FFT, decimation-in-frequency and decimation-in-time formulas allow for a 2n-point FFT to be computed by means of two n-point FFT's. Depending on the speed requirements, only one n-point FFT-unit is realized and operated twice for 2n-point FFT computation. Decimation formulas form the basis of recursive FFT computation.

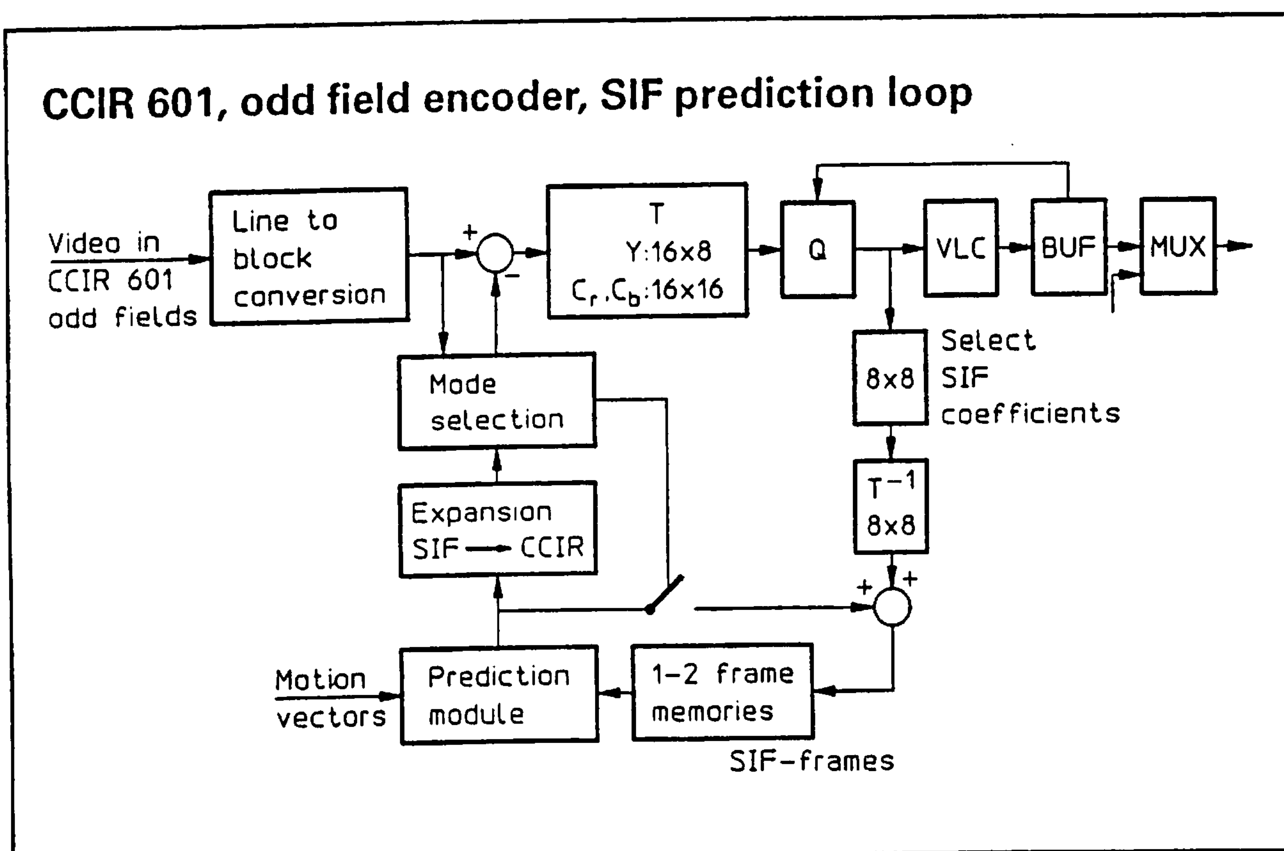

Figure 4 CCIR 601, odd field encoder, SIF prediction loop

Recently, recursive algorithms have been implemented for the DCT as well. These recursive DCT algorithms likewise express a 2n-point DCT in terms of two n-point DCT's. Hou [1] discusses an efficient and a numerically stable recursive hardware implementation of the DCT. For our purposes a fully recursive implementation is not mandatory. It suffices that a 2n-point DCT is efficiently implementable by means of n-point DCT's. Hou [1] only discusses the one dimensional DCT. However, we postulate that his results generalize to the two dimensional DCT, and that a 16x16 and 16 x 8 DCT can be efficiently implemented using 8x8 DCT units. Thereby, DCT's of sizes 16x16, 16x8 and 8x8 can be computed with the same hardware. An example of a VLSI implementation of 16x16 and 8x8 DCT is given by Chen, Sun and Gottlieb [2].

A compatible VLC is proposed: a zig-zag scan of the 8x8 SIF coefficients of each quantized 16x8 or 16x16 is performed. If the end-of-block is not inside this 8x8 block, an intermediate EOB-word for the compatible channel is added. The subsequent scanning outside the 8x8 block is for further study. The buffer regulation and channel adaptation are discussed below.

As the temporal DPCM loop conforms to MPEG, also the macroblock structure is applied on the odd fields. The compatible macroblock structure is depicted in figure 5. The motion vectors for each macroblock are obtained by a motion estimator, which is not discussed here.

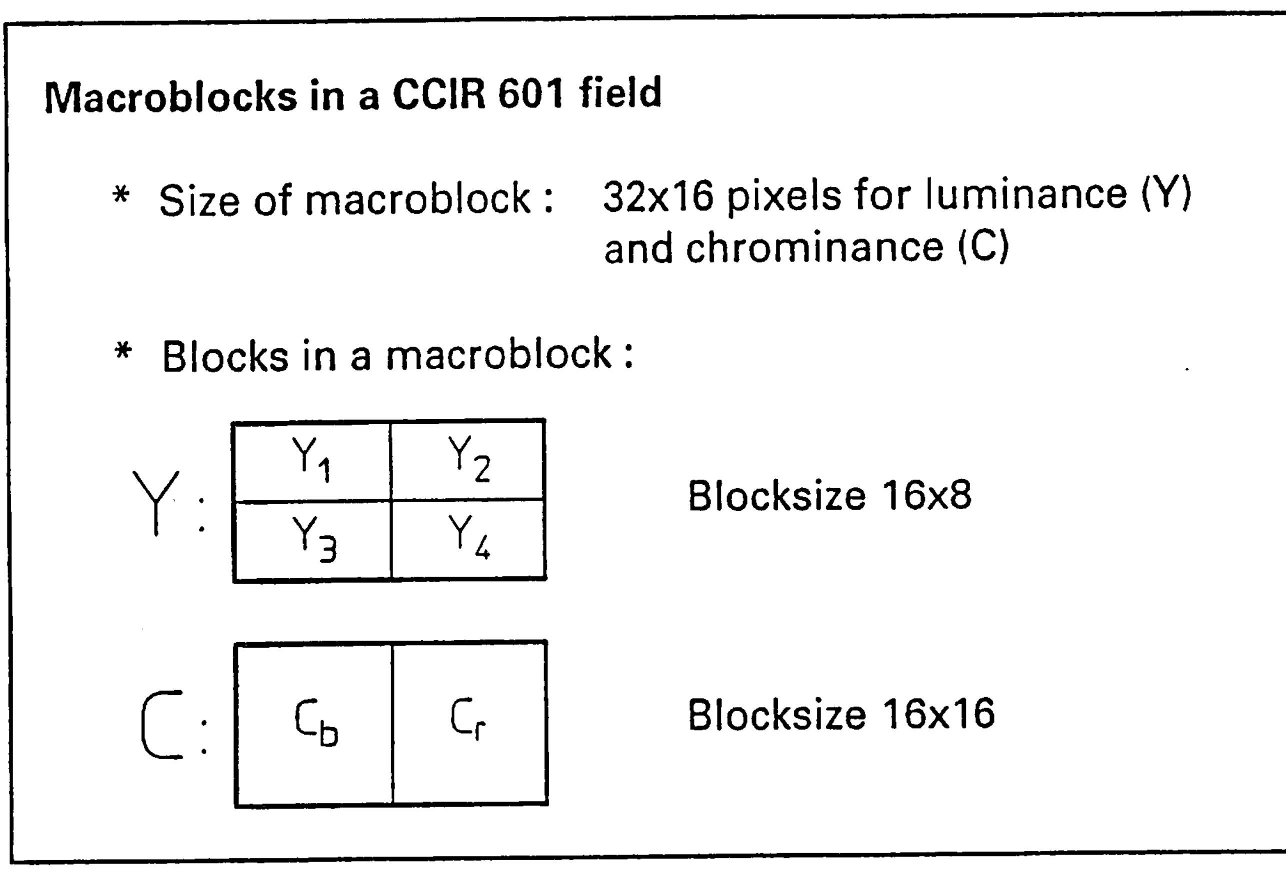

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Figure 5 Macroblocks in a CCIR 601 field

Encoding of the even fields

As the even fields don't need to be encoded in an MPEG compatible way, the prediction can be made on the entire field. Figure 6 depicts a stand-alone even field encoder. For the moment only forward prediction is proposed. This requires only one field memory in the loop, in which the previous even field is stored. The use of two field memories for the even fields is for further study.

Stand-alone even field coding is of course not our aim: the MUPCOS decoder only decodes even fields and odd fields together. Therefore, macroblock and block sizes have been chosen the same as for the compatible odd field encoder. However, the VLC can be different, as the even field information will not be MPEG compatible. A better prediction of even field macroblocks can occasionally be obtained from the neighbouring odd fields, e.g. after a scene-cut. Therefore we propose to combine the odd and even field encoders in the MUPCOS encoder.

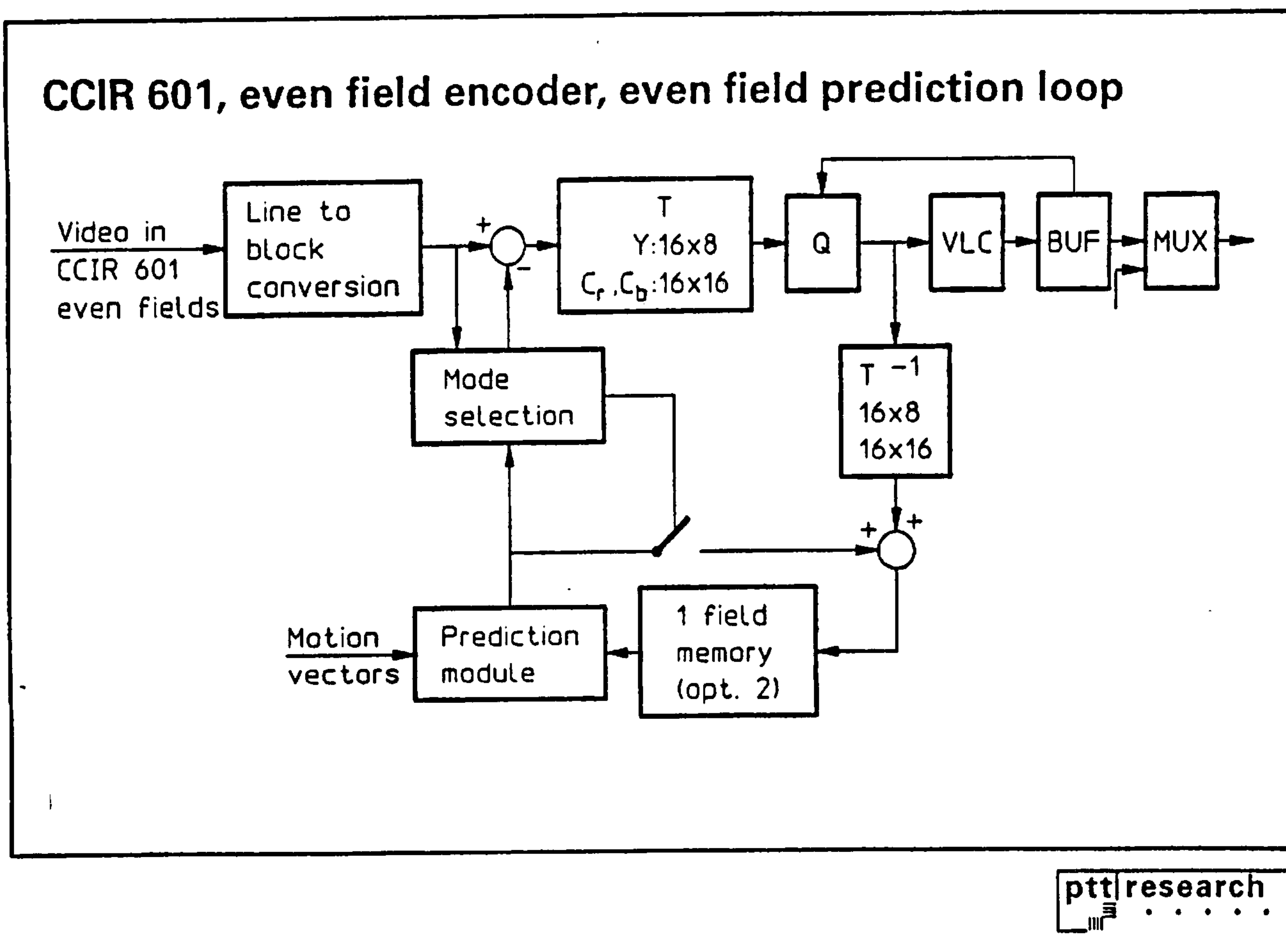

Figure 6 CCIR 601 stand-alone even field encoder

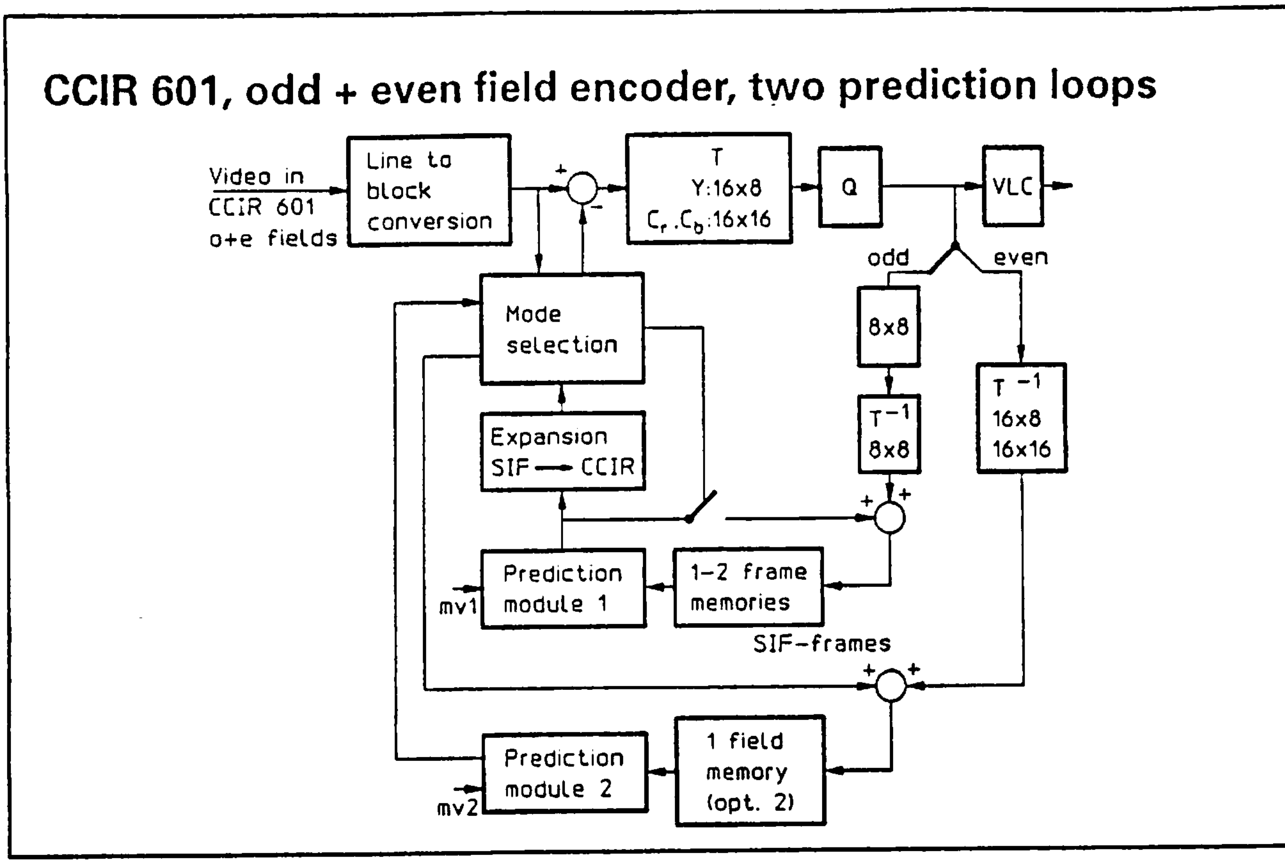

Figure 7 Draft of CCIR 601 MUPCOS encoder

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The combined odd and even field encoders are shown in figure 7. Both temporal DPCM-loops are part of the encoder and decoder. A similar architecture with two prediction loops has been proposed for TV-coding in CMTT [3].

The inner loop is the MPEG compatible loop with one or two SIF memories, depending on the application. For MPEG compatibility, the decoder must be able to use two SIF pictures for prediction.

The outer loop operates on the even fields of the CCIR pictures. As the block and macroblock structure is the same for even and odd field loops, the following prediction modes can be discerned for each macroblock:

Odd fields:

- SIF resolution part: for this part only a prediction based on the SIF fields in the upper-loop is allowed, as for MPEG.

- Additional resolution part: this resolution is not stored in the odd field SIF loop. An additional odd field loop is not considered here. More efficient coding may be obtained by extracting a prediction for these signal components from the even field loop. This is for further study.

Even fields:

Motion compensated prediction can be obtained from:

* Previous even field. According the stand-alone even field encoder.

* Neighbouring odd fields in the SIF loop. This requires conversion of the odd field SIF picture to the even field by interpolation or motion compensated interpolation. In the latter case the motion estimator should estimate the required motion vectors. This prediction mode is useful in case of a scene-cut on an odd-field. Also the periodic intra-coding, which is required every 400 ms, is only required for the odd fields.

Two channel quantization, coding, buffering and multiplexing

The coding scheme outlined above in figure 7 has the following features for compatibility:

- implicit CCIR 601 to SIF conversion in the transform domain
- compatible prediction of odd and even fields

Subsequently, following modules are considered for MUPCOS compatible coding over two channels:

- quantization (Q)
- variable length coding and video multiplexing(VLC)
- buffering and bitrate control (BUF)
- channel multiplexing, channel adaptation (MUX)

A basic set up is depicted in figure 8, with a single quantizer, variable length coding and buffer. The bits in the buffer are subdivided over the multiplexers for channel 1 (MPEG-bitstream) and channel 2. While the total bitrate is controlled by adaptation of the quantizer stepsize, there is no separate control of the bitrate of the channel 1 MPEG-bitstream. This may cause buffer overflow problems for the MPEG decoder, as it has a limited buffersize. Therefore an appropriate bitrate control for channel 1 is required.

A possibility for channel 1 bitrate control is depicted in figure 9. Here the number of transmitted coefficients in channel 1 has been made variable: a variable number of less than 8 x 8 coefficients is carried in channel 1, while the remaining SIF coefficients are carried in channel 2. As the MPEG decoder only decodes channel 1, only the coefficients which are carried in channel 1 are used for the inner loop.

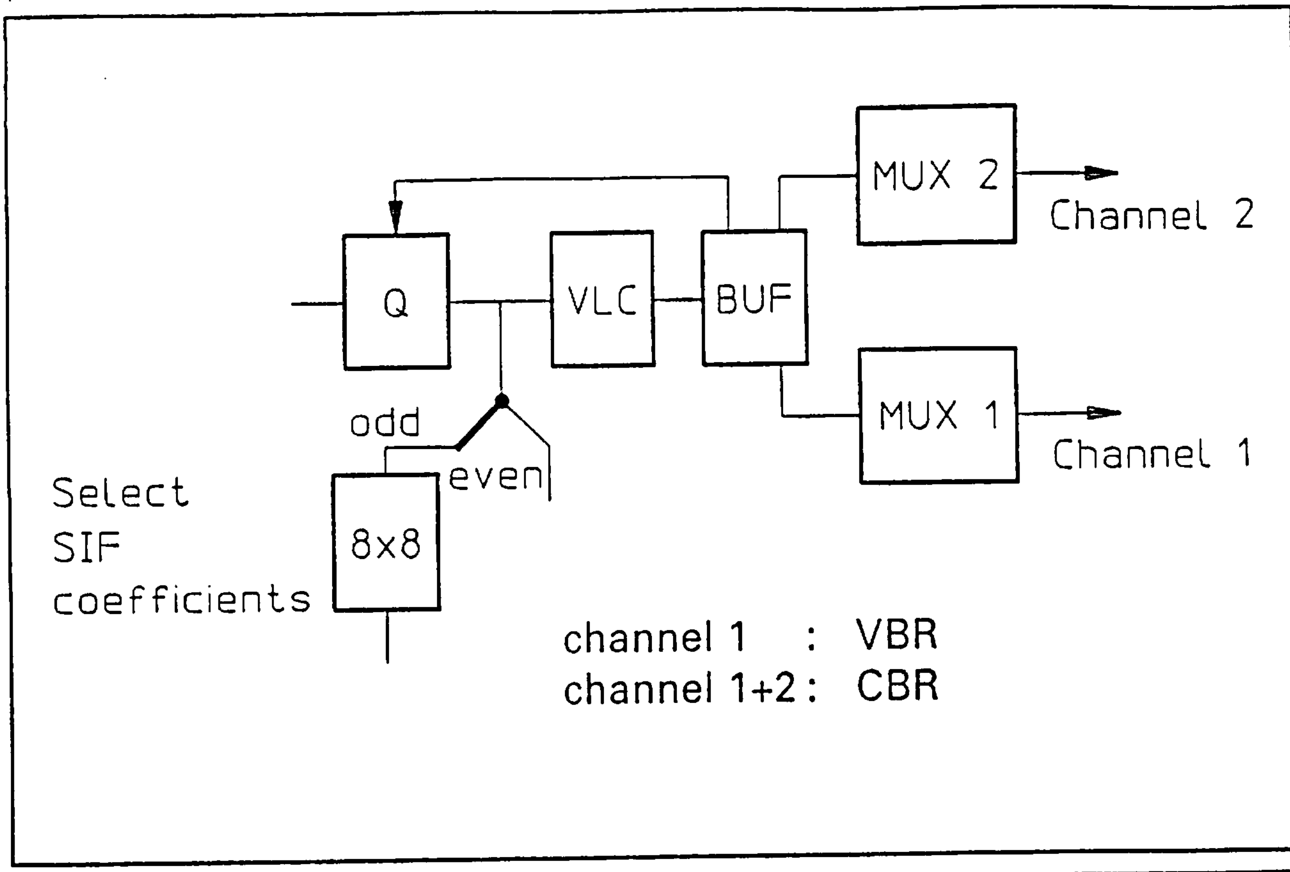

Figure 8 Basic set up for Q, VLC, BUF and MUX.

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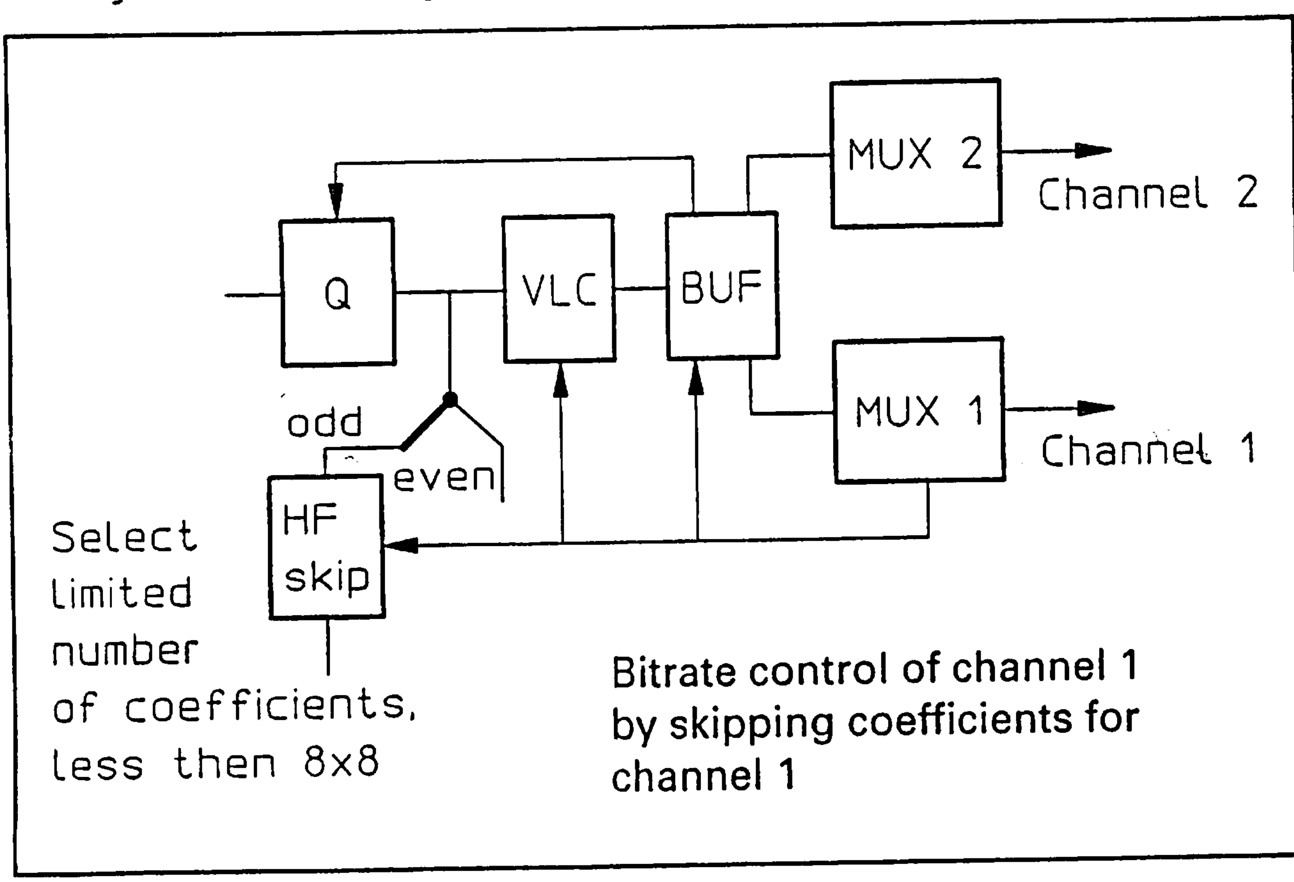


Figure 9 Basic set up with channel 1 bitrate control by skipping of coefficients for channel 1

An alternative channel 1 bitrate control is illustrated in figure 10, where two quantizers, VLC's and buffers have been drawn.

Q1 and VLC1 are for channel 1, producing the MPEG bitstream. The bitrate in channel 1 can be controlled by adaptation of Q1, based on the fullness of BUF 1. This control is independant of the channel 2 bitrate.

Q2 and VLC2 are used for (additional) quantization and coding of:

- the quantization error of Q1 for the SIF resolution (odd fields)
- the additional resolution of the odd fields
- the even fields

Quantization and coding are adapted to each of these three types of information. The bitrate in channel 2 can be controlled by adaptation of Q2, based on the fullness of BUF 2.

Joint control of channels 1 and 2 is another option, which is recommended for further study.

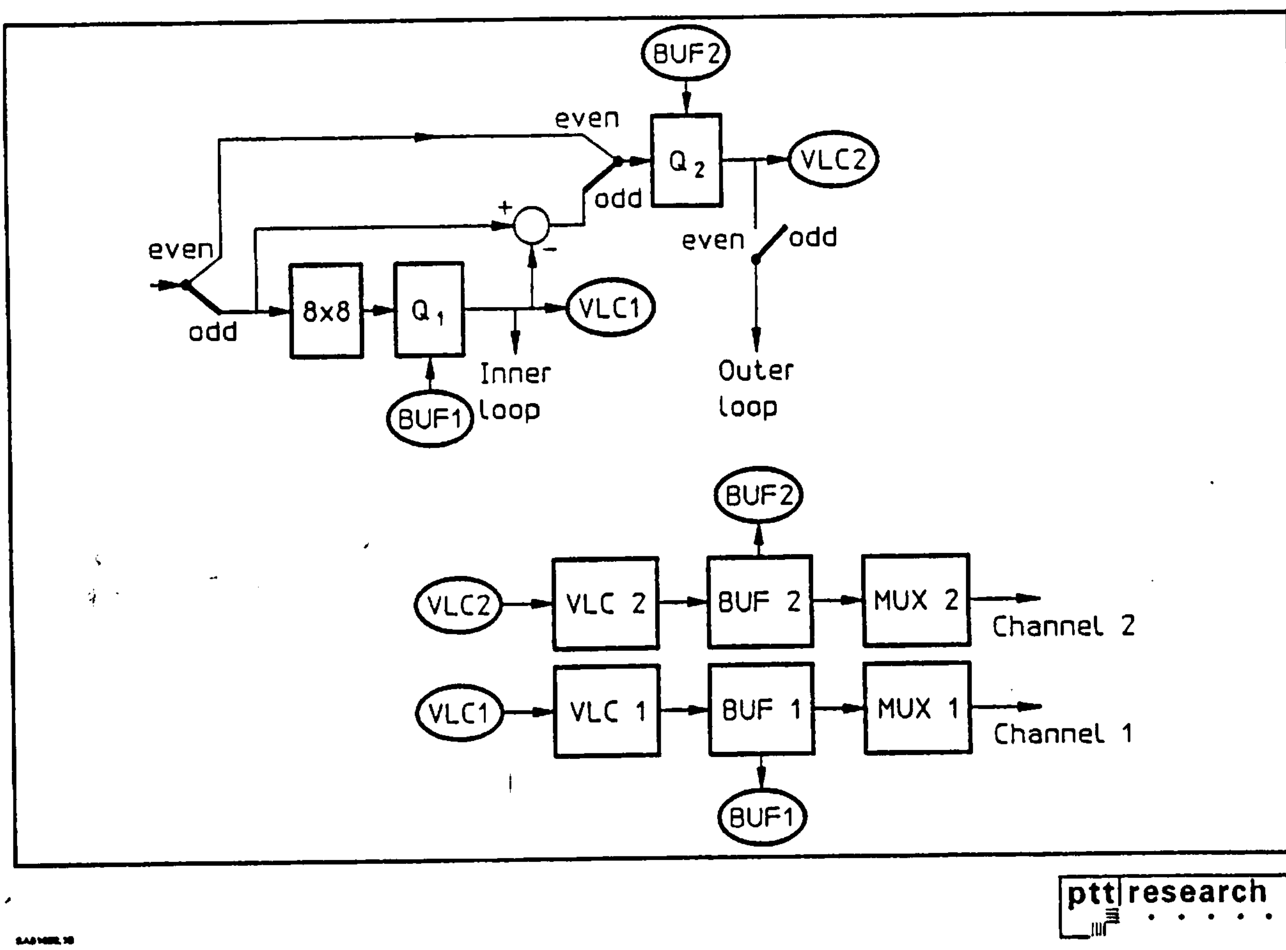


Figure 10 Separate channel 1 and 2 bitrate control, by adaptation of quantizer stepsizes of Q1 and Q2

Conclusion

The set up of a compatible CCIR 601 multi-purpose coding scheme (MUPCOS) has been discussed. This MUPCOS features compatibility with H.261 on hardware level, as the same encoder can produce a MUPCOS bitstream or an H.261 bitstream. The MUPCOS features compatibility with MPEG on videomultiplex level, as the MPEG bitstream is contained in the MUPCOS bitstream.

Allthough MPEG compatibility implies that MUPCOS can not be optimized independantly, our opinion is that the price for this compatibility is low and compatibility has to be supported.

As this proposal is only a set up, many modules in MUPCOS are subject to further study. In our opinion, the basic structure is well suited for efficient and compatible coding, while it is feasible for implementation.

References

[1] H.S. Hou, 'A fast recursive algorithm for computing the discrete cosine transform', IEEE Trans. ASSP, Vol. ASSP-35, pp. 1455-1461, No.10, Oct.1987

[2] T.C. Chen, M.T. Sun and A.M. Gottlieb, 'VLSI implementation of a 16 x 16 DCT' Proc. ICASSP '88, pp. 1973-1976

[3] CMTT/303, Draft new recommendation AT/CMTT, 'Transmission of component-coded digital TV signals for contribution quality applications at the third hierarchical level of CCITT recommendation G.702'

Source : PTT Research, The Netherlands

Title : Improvements of the multi-purpose coding scheme

Introduction

At the COST & VADIS meeting in Athens a proposal for the set up of a multi purpose coding scheme (MUPCOS) [VADIS - GR1/4] was presented.

In this scheme compatibility was achieved by encoding the full resolution signal with a 16*8 DCT for luminance, a 16*16 DCT for chrominance and to construct the compatible image with an inverse 8*8 DCT. However, in practice the compatible image shows a fair amount of ringing. Ringing occurs only if the image contains high frequency components. These components are cut off by the omission of high frequency components by the compatible image. For a one dimensional DCT, the resulting filter cut-off characteristic, considered on the time scale of the block is fairly sharp; the resulting impulse response time function becomes therefore fairly long, which shows as ringing around sharp edges in the compatible image. The compatible image is used as prediction and due to motion compensation these ringing effects become visible in the full resolution image.

The approach

An approach to ringing is to say that it is a visualisation of the filtering error of the 8*8 low frequency components which make up the compatible image. Thus the characteristic of the ringing effects has to do with the amplitudes and the length of the 8*8 low frequency DCT basis functions.

Following this approach the amount of ringing can be reduced by suppressing the highest of the low frequency components by means of a scaling down by constant factors, thereby reducing the steepness of the implicit lowpass cutoff characteristic that produces the compatible images. This weighting procedure could be made adaptive to the amount of high frequency energy present in the full resolution signal.

Implementation

For luminance and chrominance different weighting-filter matrices are used, for luminance the decimation is in vertical direction, for chrominance the decimation is in horizontal and vertical direction. For the current implementation the weighting-filter coefficients are given in table 1 and 2.

	16	16	17	17	19	21	23	27
	16	16	17	17	19	21	23	27
	16	16	17	17	19	21	23	27
1/16	16	16	17	17	19	21	23	27
	16	16	17	17	19	21	23	27
	16	16	17	17	19	21	23	27
	16	16	17	17	19	21	23	27
	16	16	17	17	19	21	23	27

Table 1: Luminance weighting-filter coefficients

	16	16	17	17	19	21	23	27
	16	16	17	18	19	21	23	27
	17	17	17	18	20	21	24	28
1/16	17	18	18	19	21	23	25	29
	19	19	20	21	22	24	27	31
	21	21	21	23	24	27	30	35
	23	23	24	25	27	30	33	39
	27	27	28	29	31	35	39	44

Table 2: Chrominance weighting-filter coefficients

The encoder from which compatible SIF pictures are obtained from the odd CCIR 601 fields is depicted in figure 1, the odd field decoder is depicted in figure 2.

The odd field enhancement encoder processes 16*8 or 16*16 blocks. The 8*8 low frequency components are formed of the difference between the original coefficients and the transmitted coefficients from the compatible channel inversely weighted-filtered (W_h^{-1}). Consequence of this operation is recoding of the 8*8 low frequency components, some of these coefficients might be coded twice. After quantisation, with a stepsize which is not necessarily equal to the stepsize in the compatible loop, the coefficients are coded with a two dimensional (run, level) VLC.

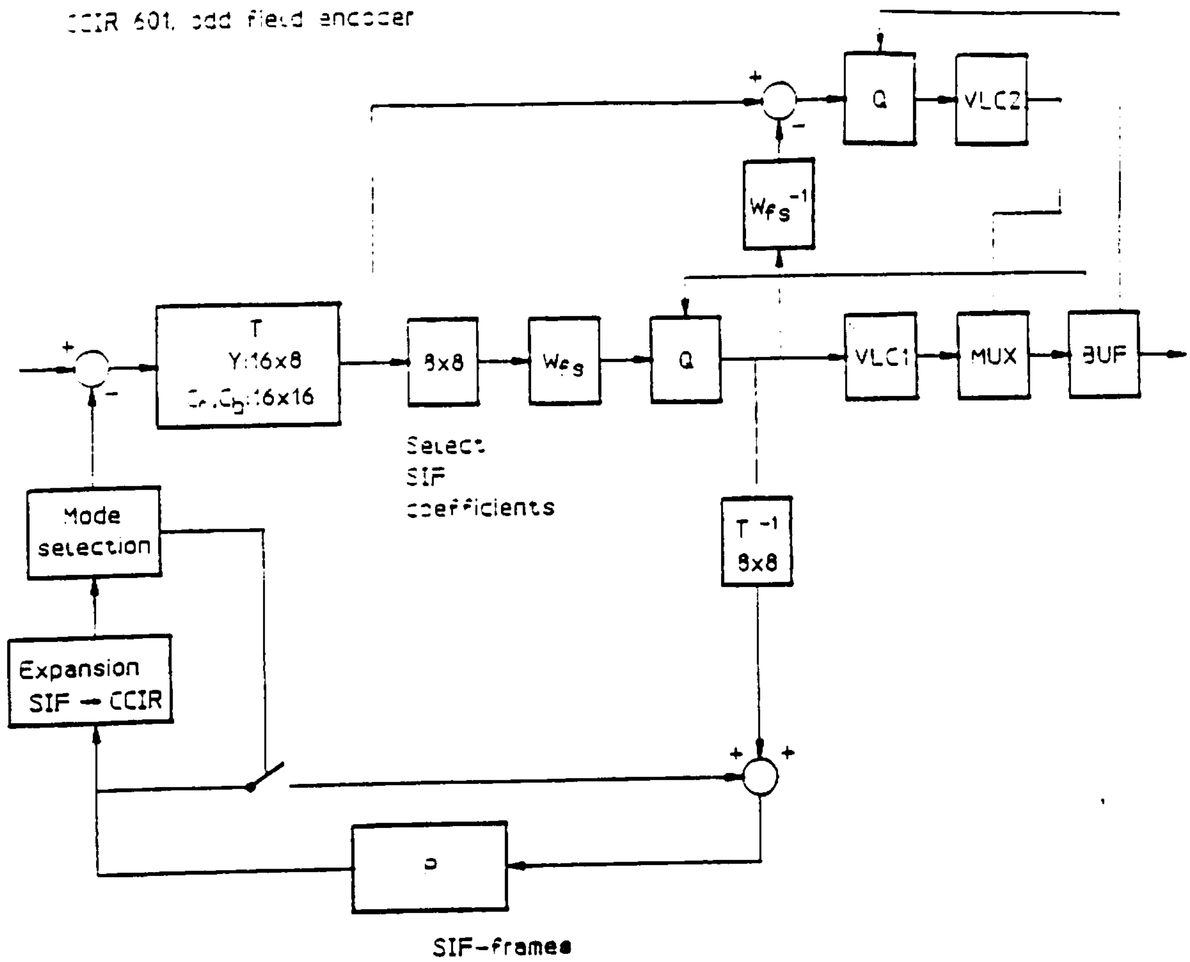


Figure 1: Odd field encoder

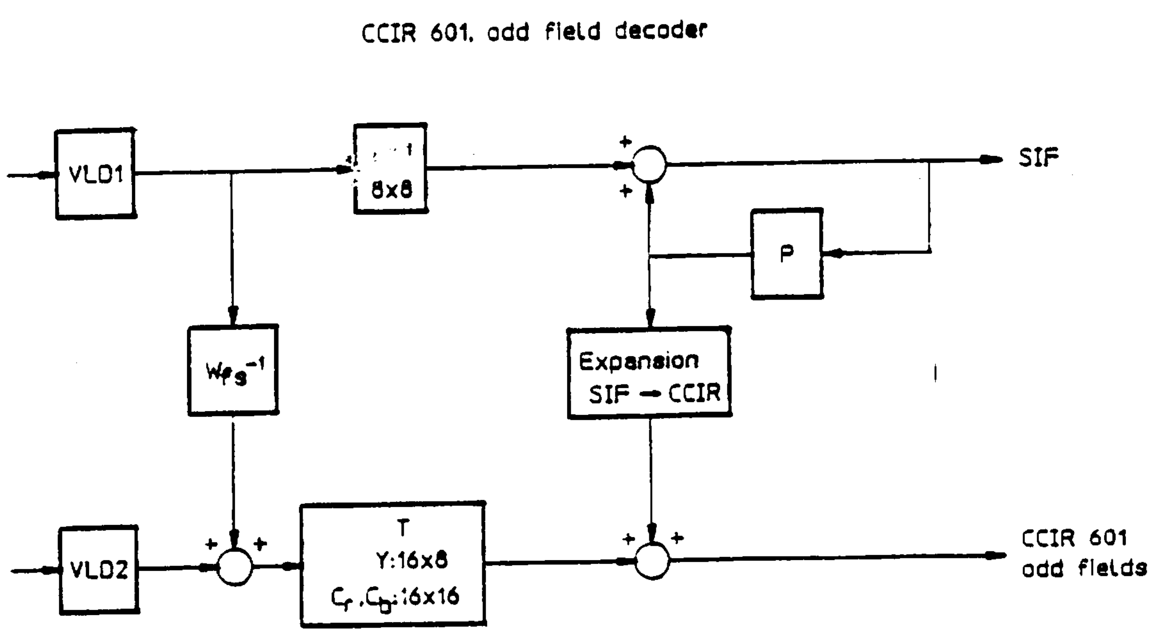


Figure 2: Odd field decoder

Source : PTT Research, The Netherlands

Title : Simulation results

In this paper simulation results of the multi purpose coding scheme (MUPCOS) [VADIS - GR1/4 and VADIS - GR1/] are presented.

The three VADIS sequences where processed at 4 and 9 Mbits/s, results will be shown on accompanying tape.

Main parameter setting

intra frame :	1 CIF frame out of 10 field is coded intra, odd fields are always coded intra and the future neighbouring even field prediction is based on the past and the future neighbouring odd CIF prediction memories. (N=10)
interpolation :	1 CIF frame out of 2 is interpolated. (M=2)
even fields :	Even fields are predicted from the past and the future neighbouring odd CIF frames or from the previous even field (except directly after a intra CIF frame). No interpolation between the several predictions is being used. Fc .he motion compensation for the previous even field half pel accuracy on CCIR fields is used.

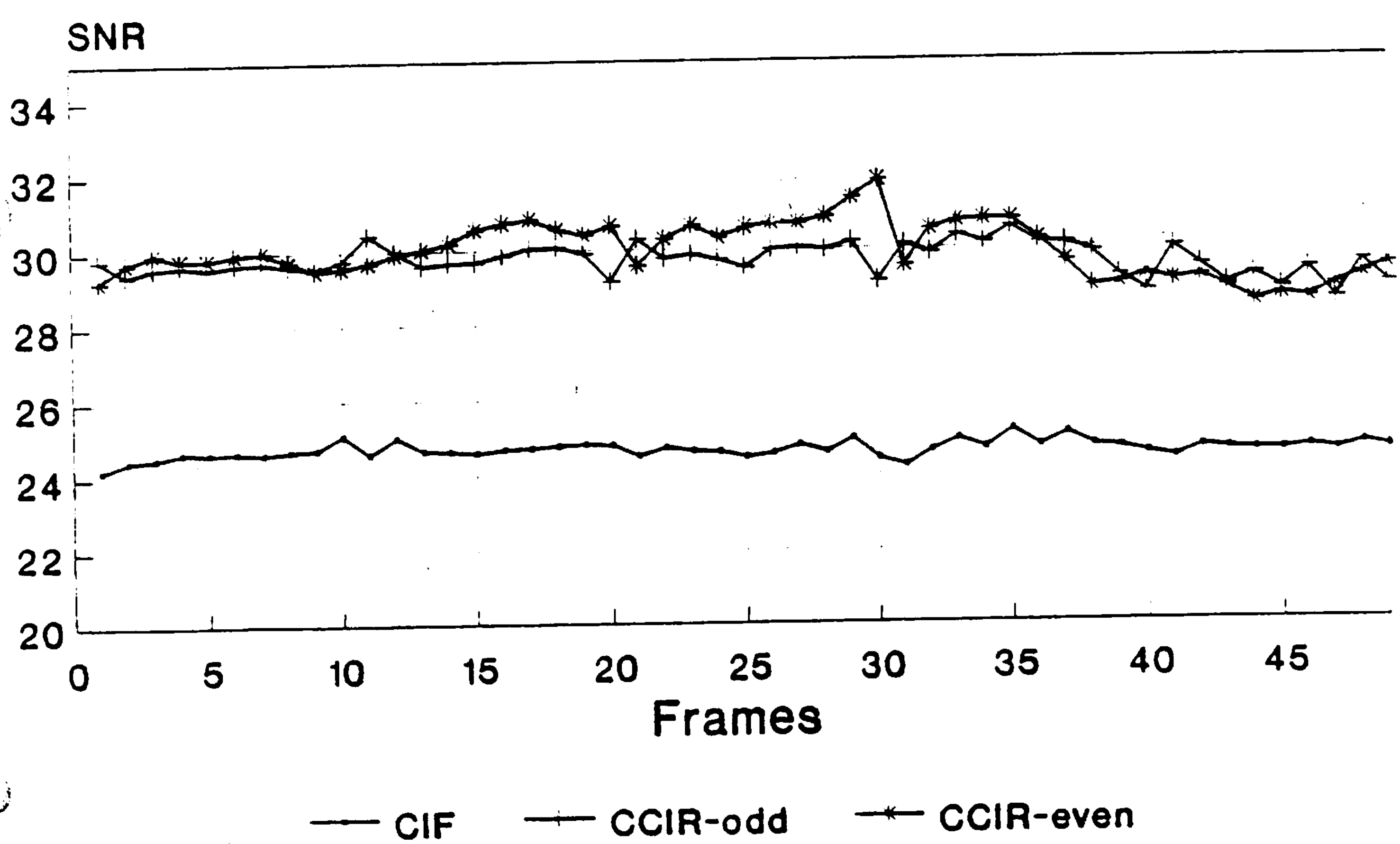
Results

For each processed sequence SNR values are given for the compatible CIF frame, the odd field and the even field. For the compatible frame and the odd field SNR values are given for the frame coding types intra, interpolated and predicted[1]. For the even field the SNR for two frame coding types are given. after_intra and normal_even. The mean value of the stepsize and mean number of bits are given.

[1]Known from MPEG1

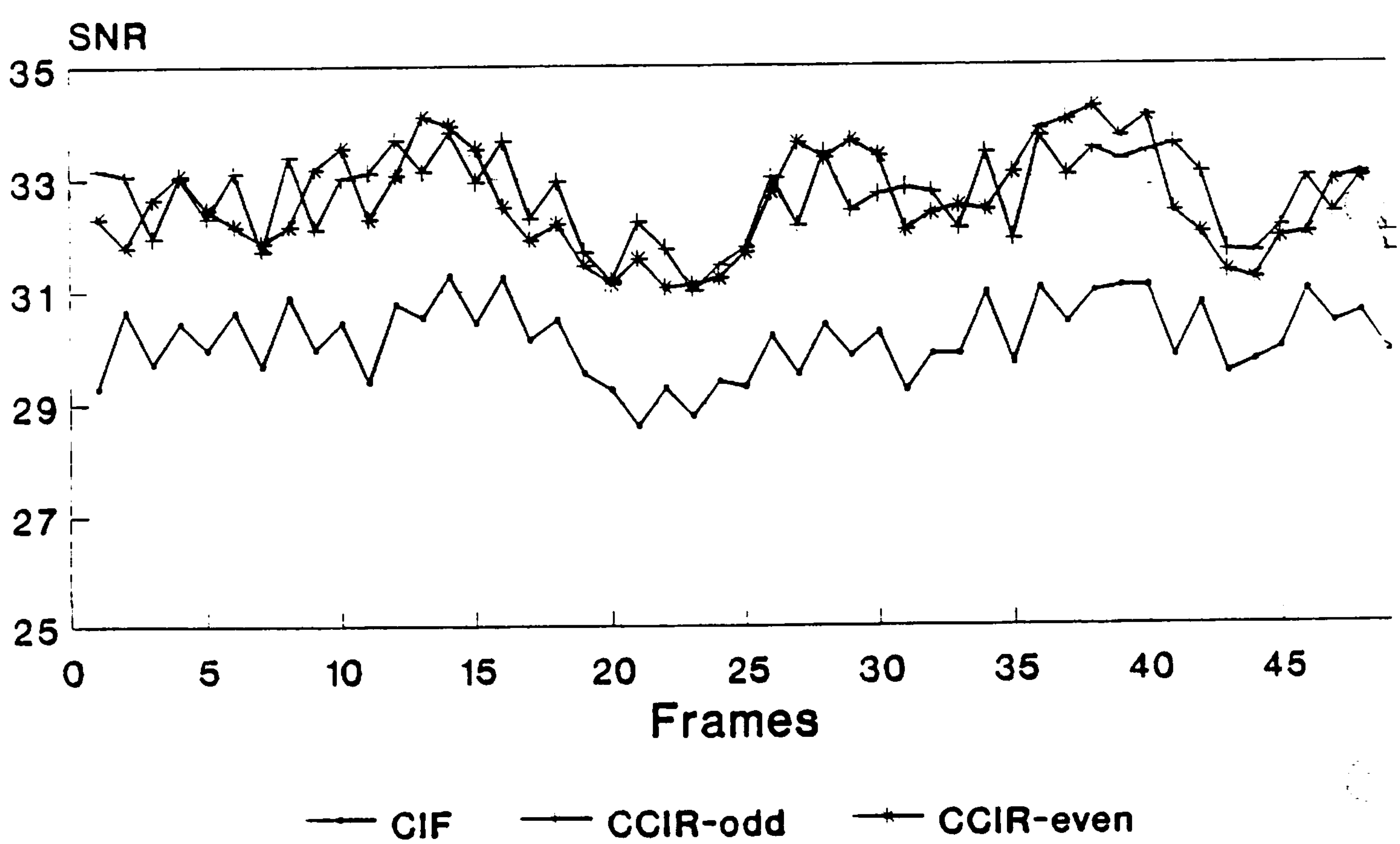
Sequence	: Calendar
Number of tracks	: 49
Framerate	: 25 Hz
Total bitrate	: 9000 kbit/s

Compatible CIF Frame	intra fr.	interpol.	predicted	mean odd
SNR for luminance	24.371	24.666	24.698	24.649
SNR for chrominance(U)	30.441	30.564	30.382	30.477
SNR for chrominance(V)	32.550	32.659	32.411	32.546
Mean value of step size	6.078	5.692	5.731	5.747
Number of bits	343200	131742	158038	164053
Odd Field	**intra fr.**	**interpol.**	**predicted**	**mean odd**
SNR for luminance	30.121	29.658	29.636	29.696
SNR for chrominance(U)	31.611	30.945	30.807	30.957
SNR for chrominance(V)	33.434	32.744	32.546	32.734
Number of bits	91968	74491	73187	75742
Even Field		**after intra**	**normal even**	**mean even**
SNR for luminance		29.427	30.002	29.943
SNR for chrominance(U)		30.928	31.202	31.174
SNR for chrominance(V)		32.707	32.838	32.824
Mean value of step size		8.022	7.838	7.857
Number of bits		196608	112410	121001



Sequence	: Flower Garden
Number of tracks	: 49
Framerate	: 25 Hz
Total bitrate	: 9000 kbit/s

Compatible CIF Frame	intra fr.	interpol.	predicted	mean odd
SNR for luminance	29.257	30.478	29.907	30.120
SNR for chrominance(U)	30.417	30.912	30.540	30.710
SNR for chrominance(V)	32.894	32.810	32.552	32.713
Mean value of step size	4.844	4.190	4.939	4.562
Number of bits	322248	136642	166756	167873
Odd Field	**intra fr.**	**interpol.**	**predicted**	**mean odd**
SNR for luminance	32.975	32.951	32.196	32.645
SNR for chrominance(U)	31.483	31.385	30.870	31.185
SNR for chrominance(V)	33.205	33.084	32.751	32.960
Number of bits	109846	59493	51441	61345
Even Field		**after intra**	**normal even**	**mean even**
SNR for luminance		32.123	32.609	32.559
SNR for chrominance(U)		31.120	31.796	31.727
SNR for chrominance(V)		32.935	33.192	33.166
Mean value of step size		5.467	5.984	5.931
Number of bits		211074	122878	131876

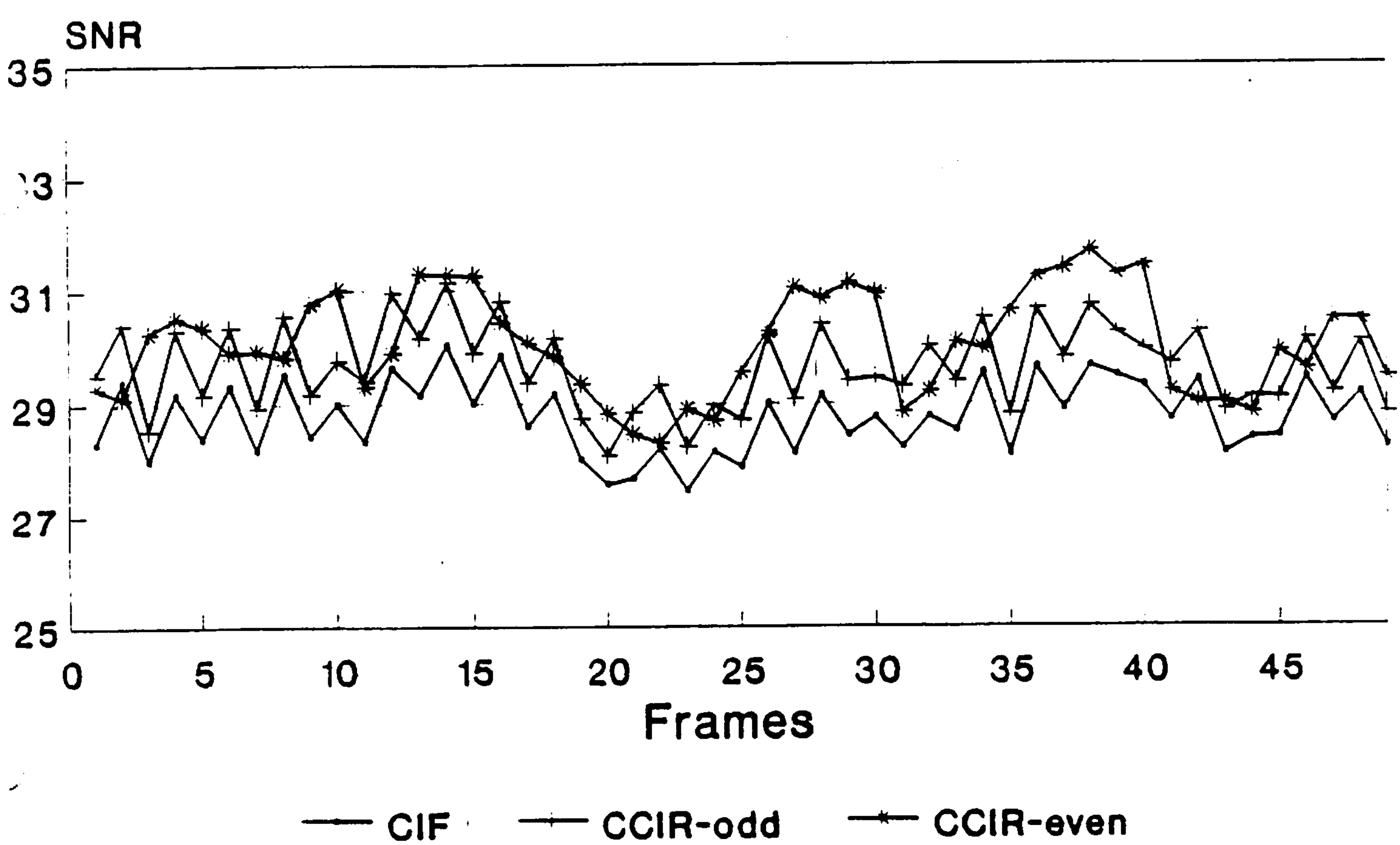


Sequence	: Flower Garden
Number of tracks	: 49
Framerate	: 25 Hz
Total bitrate	: 4000 kbit/s

Compatible CIF Frame	intra fr.	interpol.	predicted	mean odd
SNR for luminance	28.246	29.139	28.400	28.746
SNR for chrominance(U)	29.560	29.890	29.411	29.661
SNR for chrominance(V)	31.957	31.945	31.686	31.841
Mean value of step size	9.522	8.586	9.356	8.995
Number of bits	194441	75617	88449	92979

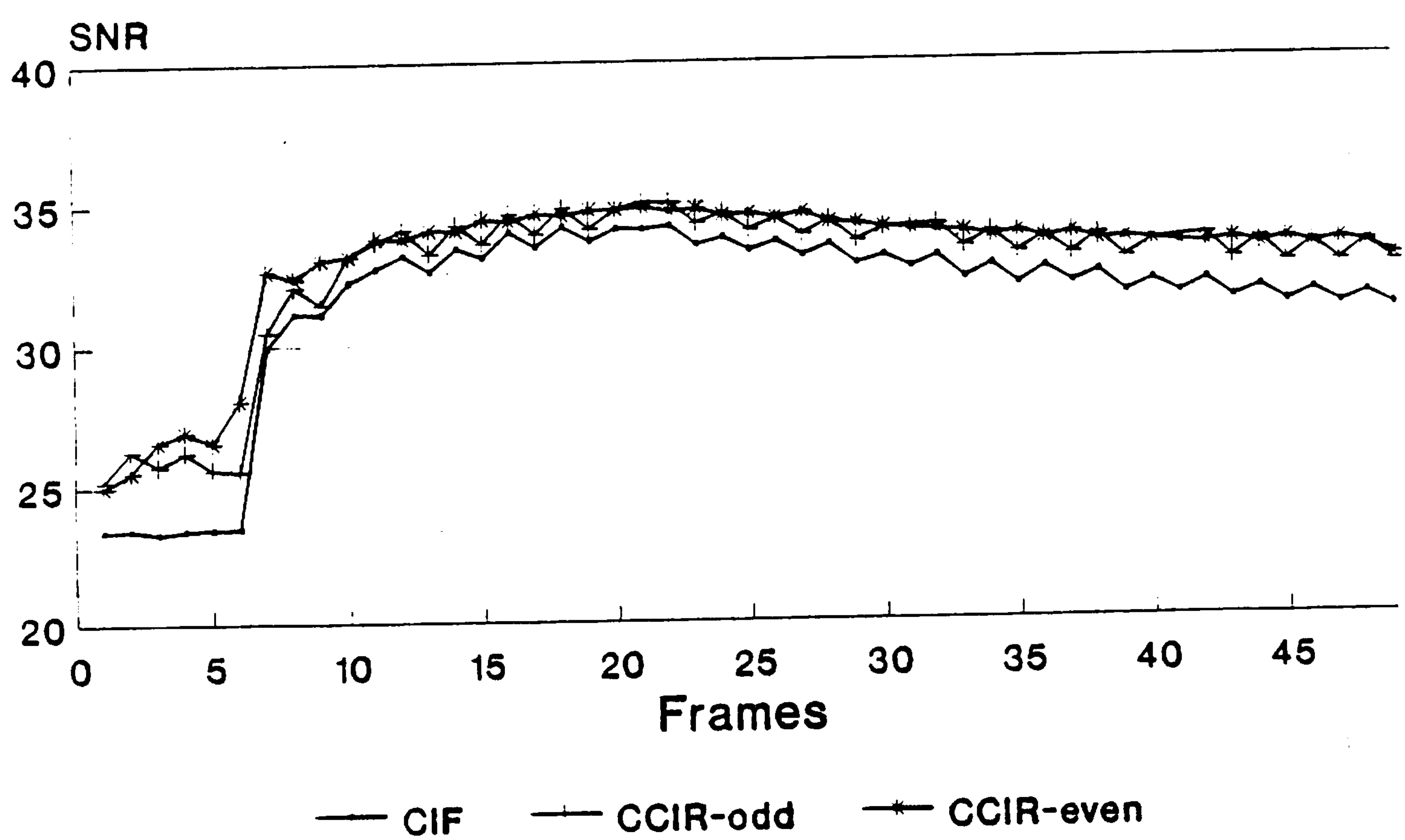
Odd Field	intra fr.	interpol.	predicted	mean odd
SNR for luminance	29.361	30.104	29.185	29.653
SNR for chrominance(U)	29.365	29.915	29.368	29.636
SNR for chrominance(V)	31.728	31.925	31.641	31.789
Number of bits	18771	12916	9959	12307

Even Field	after intra	normal even	mean even
SNR for luminance	29.026	30.169	30.053
SNR for chrominance(U)	29.421	30.377	30.280
SNR for chrominance(V)	31.789	32.030	32.006
Mean value of step size	9.889	9.879	9.880
Number of bits	92420	67844	70351



Sequence	: Table Tennis
Number of tracks	: 49
Framerate	: 25 Hz
Total bitrate	: 4000 kbit/s

Compatible CIF frame	intra fr.	interpol.	predicted	mean odd
SNR for luminance	30.879	31.671	31.293	31.436
SNR for chrominance(U)	36.106	36.240	35.950	36.108
SNR for chrominance(V)	36.253	36.447	36.006	36.247
Mean value of step size	6.989	5.088	5.939	5.629
Number of Bits	153434	75459	81085	85711
Odd Field	**intra fr.**	**interpol.**	**predicted**	**mean odd**
SNR for luminance	32.306	32.952	32.338	32.635
SNR for chrominance(U)	36.617	36.610	36.266	36.470
SNR for chrominance(V)	37.176	36.955	36.370	36.739
Number of bits	27897	23028	16450	20840
Even Field		**after intra**	**normal even**	**mean even**
SNR for luminance		32.192	33.045	32.958
SNR for chrominance(U)		36.711	36.764	36.759
SNR for chrominance(V)		37.063	37.006	37.012
Mean value of step size		7.767	6.609	6.727
Number of bits		79282	67210	68442



Sequence	: Calendar
Number of tracks	: 49
Framerate	: 25 Hz
Total bitrate	: 4000 kbit/s

Compatible CIF Frame	intra fr.	interpol.	predicted	mean odd
SNR for luminance	23.593	23.796	23.631	23.708
SNR for chrominance(U)	29.243	29.159	28.904	29.064
SNR for chrominance(V)	31.035	30.890	30.555	30.768
Mean value of step size	15.211	10.613	11.661	11.510
Number of bits	167527	67187	70788	78896
Odd Field	**intra fr.**	**interpol.**	**predicted**	**mean odd**
SNR for luminance	25.127	25.861	25.380	25.590
SNR for chrominance(U)	29.007	29.071	28.823	28.964
SNR for chrominance(V)	30.605	30.699	30.388	30.562
Number of bits	25780	26675	23973	25482
Even Field		**after intra**	**normal even**	**mean even**
SNR for luminance		25.926	27.292	27.153
SNR for chrominance(U)		29.096	29.560	29.513
SNR for chrominance(V)		30.744	31.072	31.039
Mean value of step size		14.289	11.639	11.909
Number of bits		93277	68475	71006