Doc. No. (SHARP) 50
Date: Sept. 85

CCITT STUDY GROUP XV
Working Party on Visual Telephony
Specialists Group on Coding for Visual Telephony

Source : Federal Republic of Germany

Title : Pre- and Postprocessing in Low Bitrate Video-Codecs

1. Introduction

Source coding algorithms under consideration for low bitrate codecs are by far not able to reduce the bitrate to some hundred kbit/s, if the input video signal exhibits full bandwidth and is sampled with a high sampling clock. Therefore, proper prefiltering and sampling rate decimation prior to source encoding is essential. In general, this is performed by spatio-temporal filtering and sampling-rate decimation in all three dimensions of the moving picture. This operation is called preprocessing. It can be done in the digital domain. In Fig. 1a, the main blocks of a low bitrate encoder are depicted. To show the principle, the preprocessor is divided into two parts, denoted as TS and SS. TS performs temporal filtering and temporal subsampling and SS performs spatial filtering and spatial subsampling. Within the block TS, also TV-standards conversion may be incorporated. Then some vertical filtering and vertical subsampling is done within TS as well. At the output of the preprocessor, the reference point B is defined in accordance with Doc. No. 32R (April 85). The luminance signal and the two colour difference signals have to be specified at this point.
In Fig. 1b, the decoder with blocks for temporal and spatial interpolation, TI and SI, is depicted. The present document focus on spatial filtering for sampling rate decimation (SS) and interpolation (SI).

In Doc. No. 26 (April 85) the advantages of spatial diagonal filtering and sampling-rate decimation with a line-quincunx pattern were pointed out. This technique can maintain the horizontal and vertical resolution of the picture and can provide a reduction factor 1:2 for the sampling-rate. In the present document, further details are given and the resulting quality for natural pictures is discussed.

2. The Principle

In Fig. 2a the principle block diagramm for spatial diagonal filtering and sampling-rate decimation is depicted. The numbers in brackets indicate assigned sampling patterns (Fig. 2b) and two-dimensional spectra (Fig. 2c). The input signal at point (1) exhibits an orthogonal pattern and a rectangular shape of the baseband spectrum ((1) in Figs. 2b, c). The small circles in Fig. 2c indicate the periodicity of the spectrum. The spatial diagonal filter yields a spectrum with a diamond shape, (2). The sampling pattern remains orthogonal. After subsampling, the sampling pattern and the periodicity of the diamond shaped baseband change ((3) in Figs. 2b, c).

3. Filtering and Subsampling of the Luminance Signal

Computer simulations were performed for the different spatial filters depicted in Fig. 3 and the resulting picture quality was evaluated. The natural still pictures "Kiel Harbour" and "Playboy" were used. In Tab. 1, the sampling parameters and the sampling-rate reduction factors are listed. Method A employs the digital studio standard given in CCIR-Rec. 601. Method B provides nearly no visible degradation for natural pictures, C exhibits some loss of sharpness for vertical contours. The horizontal and vertical resolution is not balanced. D provides a visible degradation. The picture quality obtained from E is quite similar to D, but method E can provide a reduction factor which is by a factor 2 larger.

As a result, B is suitable for codecs operating at primary rates m • 384 kbit/s (m = 4 and 5) and with some restrictions for encoding of graphics. For 384 kbit/s, method E is appropriate, but some loss of sharpness has to be tolerated. For encoding with 64 kbit/s, a further reduction of the sampling rate has to be studied.

4. Filtering and Subsampling of the Colour Difference Signals

Computer simulations were performed for different spatial filters depicted in Fig. 4 and the resulting picture quality was considered. The natural pictures "Kiel Harbour" and "Playboy" were used. In Tab. 2 the sampling parameters and the sampling-rate reduction factors are listed. Method I employs the digital studio standard given in CCIR-Rec. 601. The performance of II is quite similar to I. Methods III and IV provide tolerable degradations in quality and are well suited for codecs operating at primary rates. The degradations resulting from methods V and VI are visible, but not annoying. V and VI are well suited for codecs with 384 kbit/s. Method VI provides the largest reduction factor 1:16.

5. Conclusions

Various spatial filters for sampling rate decimation and interpolation have been presented. The resulting picture quality was studied by computer simulation using natural still pictures. For encoding with 384 kbit/s, the following parameters are appropriate: Luminance signal: 288 lines/picture, 180 pels/line, line-quincunx sampling pattern or 360 pels/line with orthogonal pattern; chrominance signal: 144 lines/picture, 90 pels/line, line-quincunx sampling pattern or 180 pels/line with orthogonal pattern. For codecs operating at primary rates, the parameter set B in Tab. 1 for the luminance signal and set IV in Tab. 2 for the chrominance signals are well suited. A graphics encoder, which should be part of the low bitrate codec, should have full resolution according to CCIR-Rec. 601. The influence of a line quincunx sampling pattern on source coding algorithms is under study.

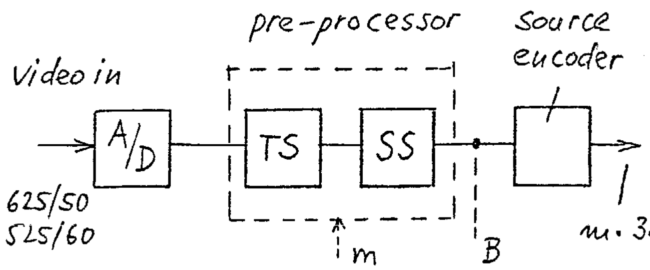

Fig. 1a

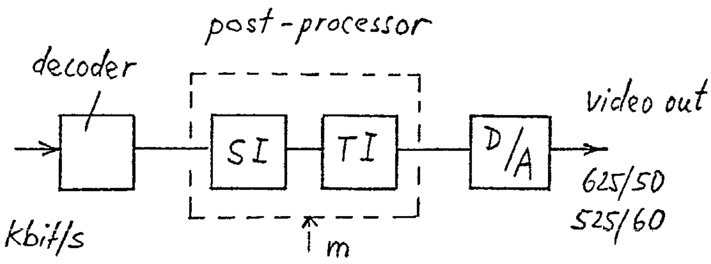

Fig. 1b

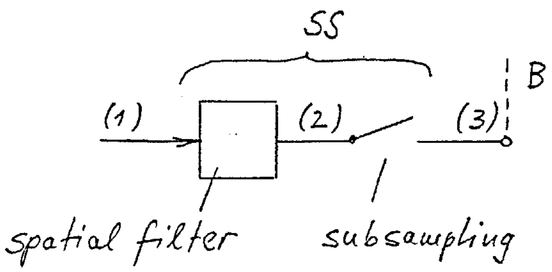

Fig. 2a

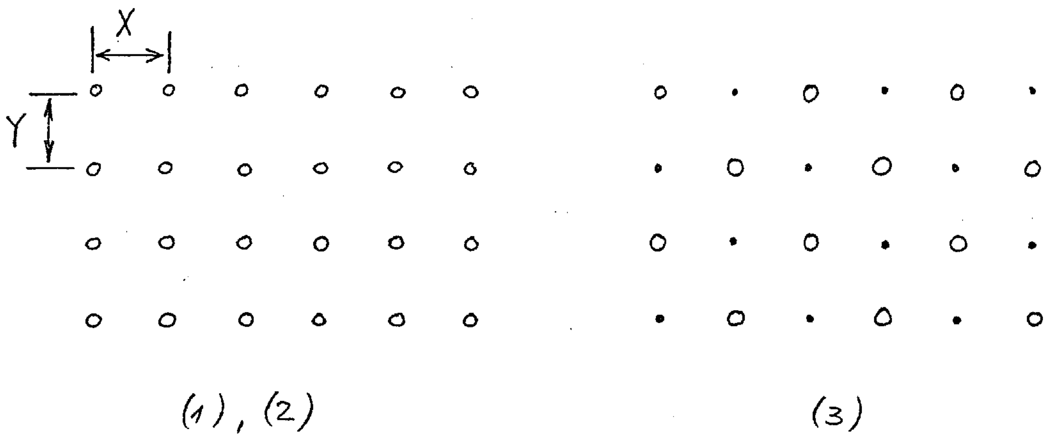

Fig. 2b

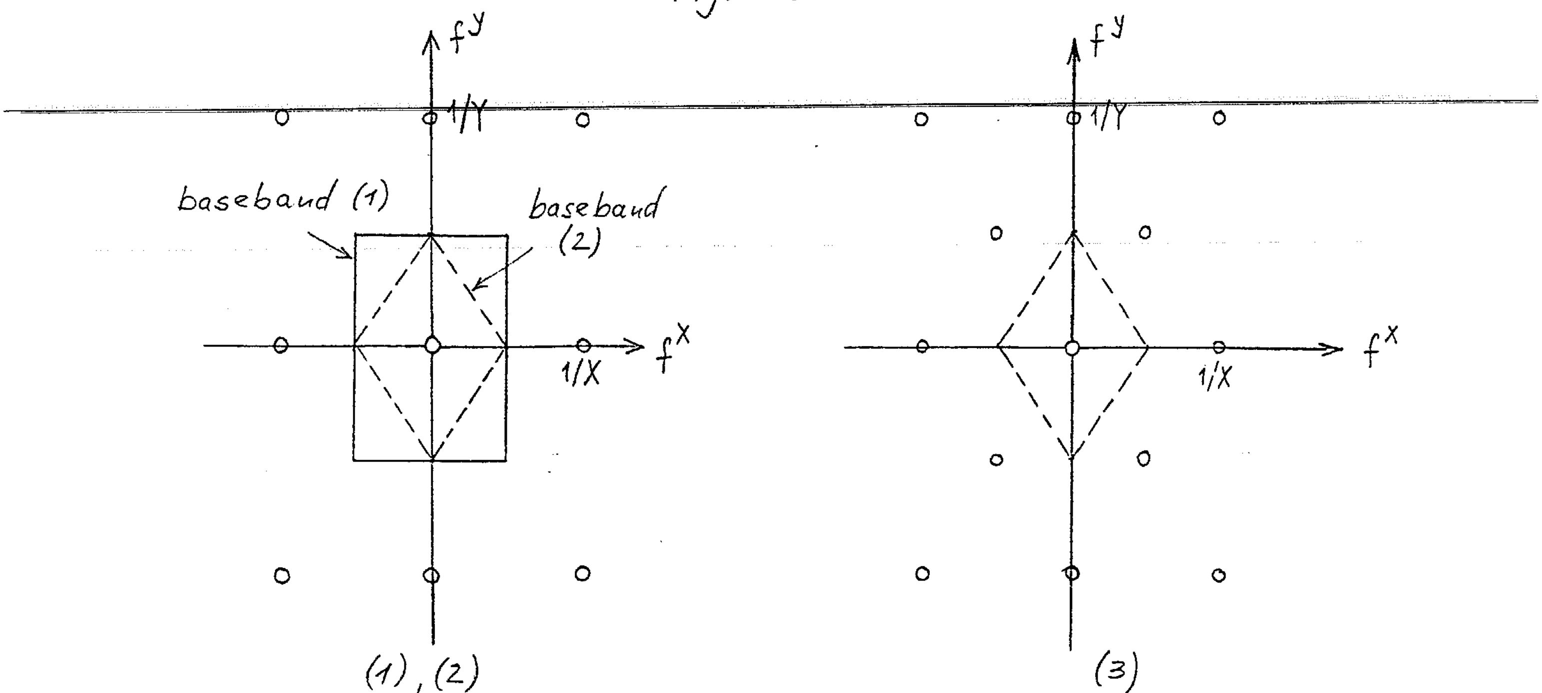

Fig. 2c

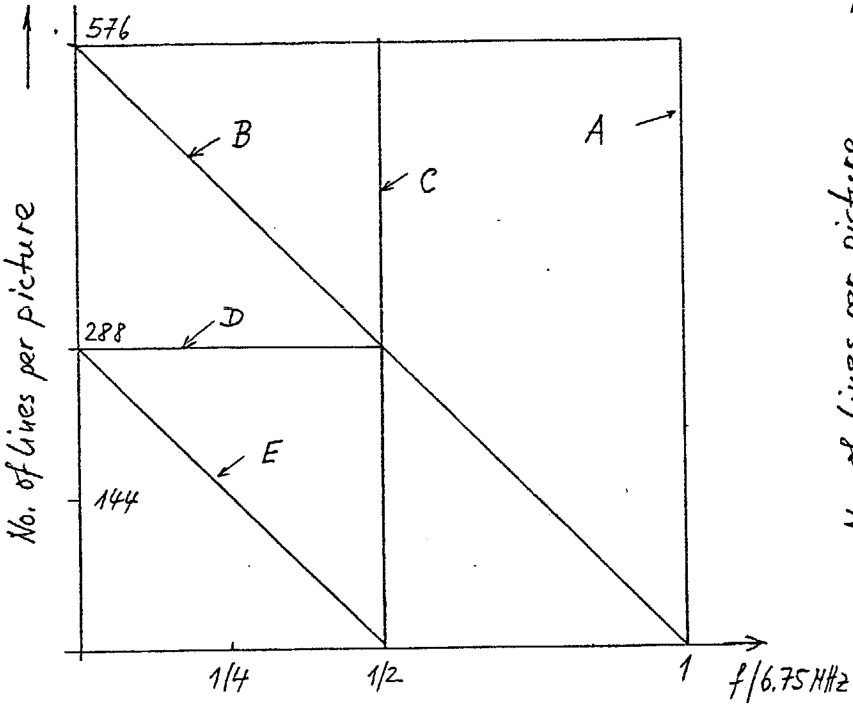

Fig. 3 : Luminance

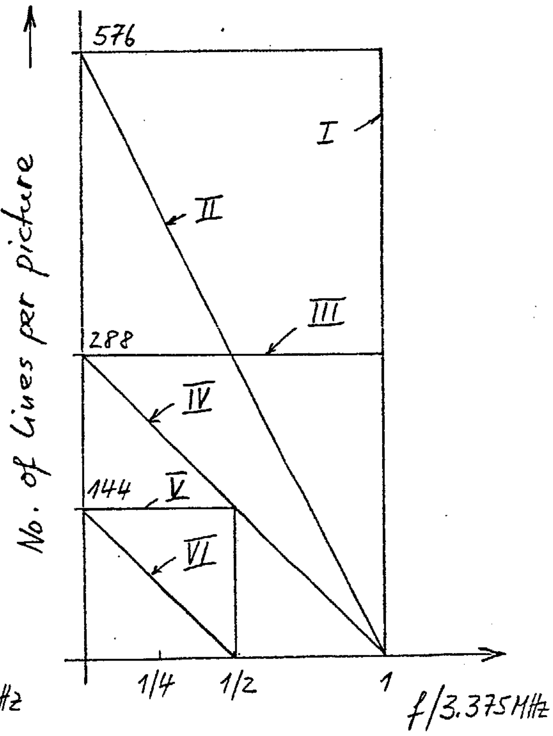

Fig. 4 : Chrominance

spatial filter	No. of lines per picture	No. of pels/line	sampling structure	horiz.resol. in pels/line	sampl. rate reduction factor	application
A (CCIR 601)	576	720	orth.	720	1	graphics
B	576	360	quincunx	720	1:2	graphics m • 384 kbit/s (m=4 and 5)
C	576	360	orth.	360	1:2	
D	288	360	orth.	360	1:4	384 kbit/s
E	288	180	quincunx	360	1:8	

Tab. 1: Luminance

spatial filter	No. of lines per picture	No. of pels/line	sampling structure	horiz.resol. in pels/line	sampl. rate reduction factor	application
I (CCIR 601)	576	360	orth.	360	1	graphics
II	576	180	quincunx	360	1:2	
III	288	360	orth.	360	1:2	m • 384 kbit/s (m=4 and 5)
IV	288	180	quincunx	360	1:4	
V	144	180	orth.	180	1:8	384 kbit/s
VI	144	90	quincunx	180	1:16	

Tab. 2: Chrominance