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Specialists Group on Coding for Visual Telephony

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Title: Proposal on a Video Interface and an Example of Pre-/Post-Processing

1. INTRODUCTION

In this document a proposal on a video interface for low bit-rate codecs is given, where the demands of face-to-face and graphics transmission as well as the various TV-standards are taken into consideration. It will be outlined, that at least for face-to-face transmission a digital pre- and post-processing is required and an example is given.

2. VIDEO INTERFACE WITH A/D-D/A-CONVERSION

A video interface should accomplish the following requirements

a) allow efficient redundancy reduction techniques as well as pre- and post-processing of the signals
b) allow component video signals with full bandwidth, e.g. for graphics pictures
c) allow different TV-standards to be coded and decoded
d) allow composite video signals
e) allow colour video signals
f) allow interconnection of digital video signals.

For low bit-rate codecs, the first item is of major importance, which leads to an interface for the luminance signal Y and colour-difference signals R-Y and B-Y and a sync signal S, as depicted in Fig. 1. To save hardware, it is desirable to have one interface circuit for both, face-to-face and graphics pictures. To maintain a high resolution for the graphics or for nonmoving areas in a conditional-replenishment type of codec, the A/D- and D/A-converters have to operate with a high sampling rate.

A good solution is to use the sampling frequency 13.5 MHz for Y and 6.75 MHz for R-Y and B-Y and the ratio 4:2:2 according to CCIR 601. This is an already agreed sampling standard which meets all requirements listed above, except d).
In /1/, sampling parameters, signal ranges and normalizations of signal levels are discussed.

The decision for a component signal interface for the low bit-rate codec takes two additional facts into consideration:

Monitors: It is easy to provide analogue interfaces for component signals. Already at present, there is a monitor on the market exhibiting this feature.

Cameras: Three-tube cameras for high quality colour signals provide RGBS. The component signals Y, R-Y, B-Y and S occur in the camera as well. The latter also holds for one-tube and solid state colour cameras.

The specialists group deals with low bit-rate codecs of second generation, which are also intended to be used for a future videotelephone service. These activities are regarded with much interest by manufacturers of video equipment. The recommendation for a video interface would give a gideline and an impact to these producers.

3. OPTIONAL INTERFACES

a) Composite signal interface
   At present, for most video tape recorders and video-disc players composite signals are required. Also analog transmission systems, partly in use for intra-regional video transmission, require composite signal formats. For this, composite signal encoder/decoder should be available as options (Fig. 1).

b) RGBS to/from Y, R-Y, B-Y and S

Options a) and b) may be implemented with analogue or digital circuits and thus connected to the analogue or digital video interface, respectively.

c) Digital video interface

The digitized signals Y, R-Y, B-Y can be arranged to form a 8 bit wide data stream with 27 Mwords/s. On a ninth line, a synchronous 27 MHz clock can be provided. The specification of a bit-parallel interface on this basis is described in /2/.

4. PRE- AND POST-PROCESSING

Coding shemes under consideration for redundancy reduction operating on the basis of 13.5/6.75/6.75 MHz are by far not able to reduce the bit-rate to some hundred kbit/s with good quality for full motion pictures. Thus, pre-processing of the digital video signal prior to encoding is required for face-to-face pictures. This can be done using spatial and temporal filters in the digital domain. A reduction of the horizontal and vertical sampling frequency, e.g. by integer factors, would result in a lower horizontal and vertical resolution of the picture and should therefore be introduced in a second stage, controlled by the coding law of the encoder. In a first stage, a spatial filter and a subsequent diagonal sampling structure, also refered to as line quincunx structure, can be used.

In the following, an example of pre-processing by spatial filtering (2D-filtering) is given. The spatial filter is designed such, that it reduces the definition of the picture in oblique directions, as shown in Fig. 2, whereas the horizontal and vertical definition is maintained. This filtering operation puts no negative impact on the picture quality for two reasons:

a) For oblique structures in a picture, the human visual system is not as sensitive as for horizontal and vertical ones ("oblique effect", Fig. 3).

b) Oblique structures are less frequent in natural pictures than horizontal and vertical ones (Fig. 4).

Diagonal spatial filtering with subsequent line-quincunx sampling reduces the sampling frequency by 2:1. A non-interlaced picture format is advantageous.
A futher reduction of the sampling rate can by obtained by applying field or frame quincunx structures combined with temporal filters.

The pre-processed video signal is fed into the encoder for redundancy reduction, as depicted in Fig. 1. Note, that the choice of coding algorithms has to take the sampling structure into consideration, and that the interaction has to be studied. At the receiving end, post-processing is used. In principle, pre- and post-processing are reverse operations.

5. Conclusions

A video interface is proposed on the basis of the luminance signal and the colour difference signals sampled at 13.5 MHz and 6.75 MHz respectively, according to CCIR 601. This interface is common to face-to-face and graphics signals. Interface circuits for composite signals, RGB and bit-parallel digital signals are options. To reduce the high sampling rates, pre-processing prior to encoding for redundancy reduction is proposed. An example is given using spatial diagonal filtering followed by subsampling 2:1 in a line quincunx structure. This process maintains the horizontal and vertical resolution and thus the quality of the picture.

Literature

/1/ CCIR Doc. 11/214-E, "Draft Revision of Recommendation 601", Sept. 1983

/2/ CCIR Doc. 11/202-E, "Draft New Recommendation, Bit Parallel Digital Interface for Component Video Signals in 525-Line and 625-Line Television Systems", Sept. 1983

/3/ Watanabe, A., Mori, T., Nagata, S., Hiwatashi, K., "Spatial Sine-Wave Response of the Human Visual System", Vision Research, 8, 1968, pp. 1245-1263

/4/ Keskes, N., Kretz, F., Maitre, H., "Statistical Study of Edges in TV Pictures", IEEE Trans. on Com., COM-27, Aug. 1979, pp. 1239-1246

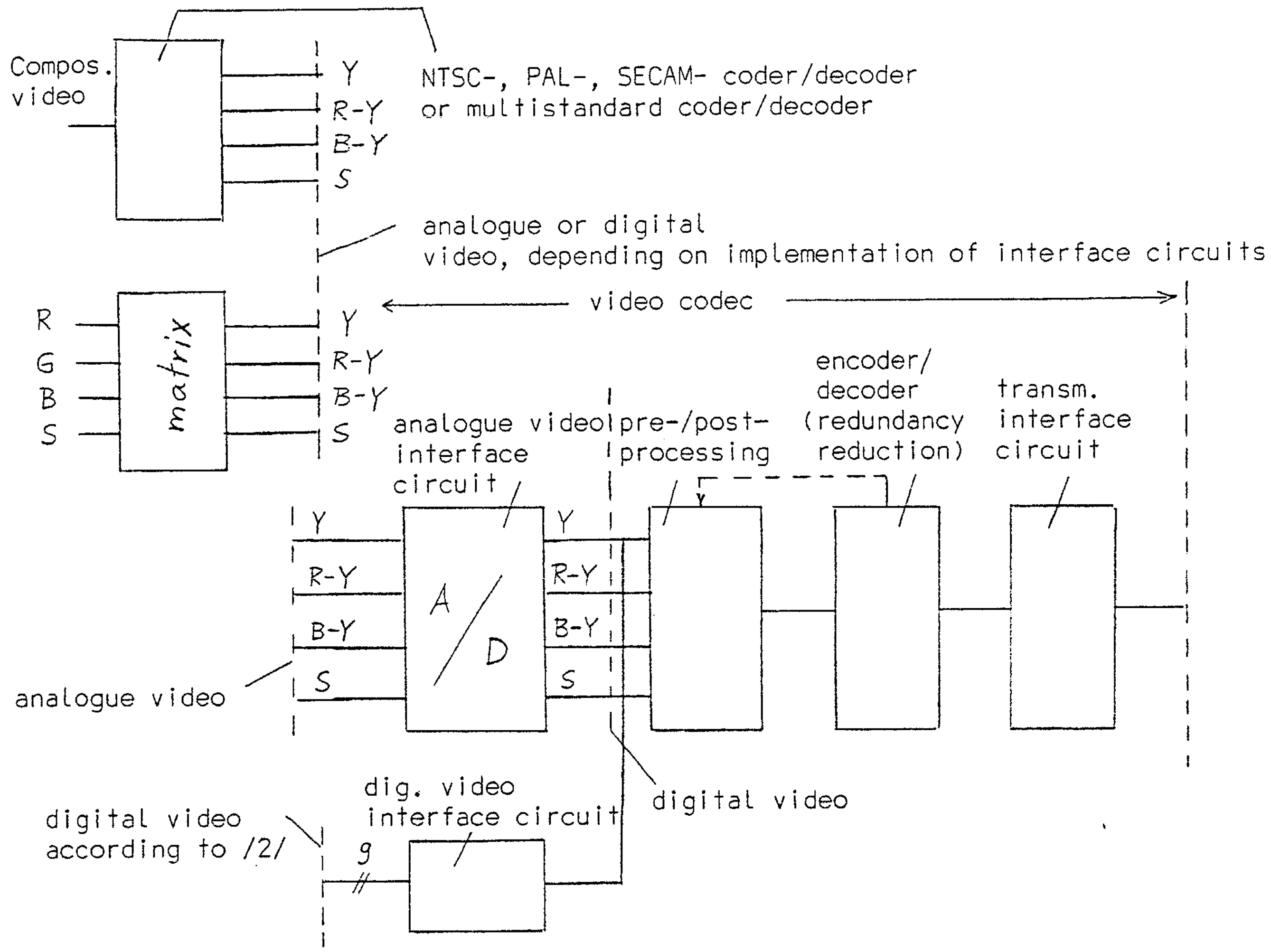

Fig. 1: Low bit-rate video codec with video interface circuits

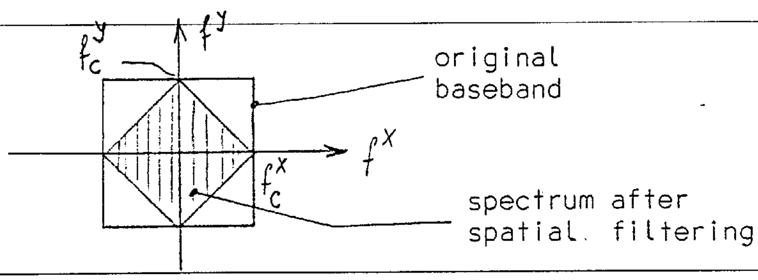

Fig. 2: Reduction of resolution in diagonal direction by spatial filtering

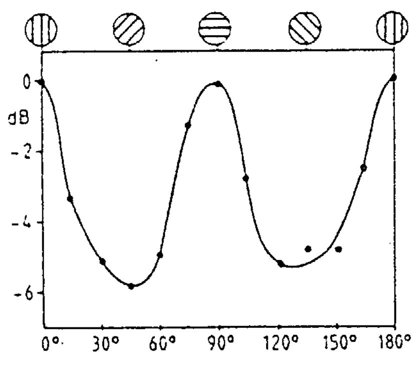

Fig. 3: Relative contrast-sensitivity of the visual system versus orientation of a sinusoidal pattern (from /3/)

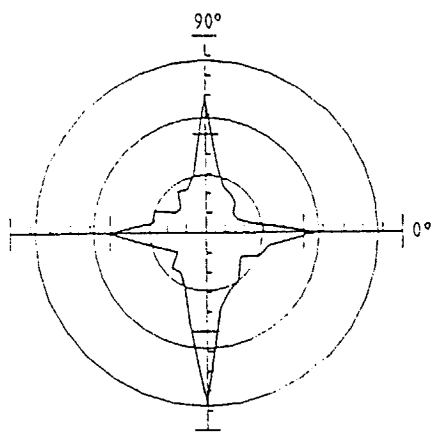

Fig. 4: Probability of the orientation of edges in natural pictures (from /4/)