CCITT SGXV
Working Party XV/1
Experts Group for ATM Video Coding

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TITLE : Objective evaluation scheme for picture format conversion

PURPOSE : Proposal

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1. Introduction

An objective evaluation scheme for picture format conversion is proposed and examples of evaluation results are shown.

2. Objective evaluation scheme

When we specify a common picture format for higher bit rate applications, converted picture quality between the common format and local formats is a major factor for consideration.

There exist, however, some problems when we try to evaluate converted picture quality as follows.

Problems:

- SNR cannot be calculated between the original picture and converted pictures because their formats differ from each other.
- In a common picture format communication, input local picture formats and output local picture formats are selected independently. This suggests that a common format picture which has a similar contents to the original provides a better converted picture quality. There has been, however, no objective scheme for evaluating common format picture quality.
- Picture formats of input/output devices and test video sequences are limited.

Due to these problems performance of picture format conversion has been investigated for few formats by subjective evaluation. But in the standardization work for SCIF definition it is required to confirm whether high picture quality is maintained through the conversion among several picture formats as shown in Table 1 and Fig. 1 (AVC-106R). For an efficient objective evaluation, we propose the following scheme :

Table 1 Picture formats under consideration

Format	line/frame	frame/sec.	Interlace/Non-interlace	Chrominance	Note
1	480	60	Interlace	4:2:2	525 local format
2	480	60	Non-interlace	4:2:2	-------
3	576	50	Interlace	4:2:2	625 local format
4	576	50	Non-interlace	4:2:2	-------
5	576	60	Non-interlace	4:2:0 (?)	SCIF (candidate)
6	288	30	Non-interlace	4:2:0	FCIF

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Source                      Transmission                             Display
Format 1 ------------> |      | -------------------> |         | ------------> Format 1
Format 2 ------------> |      | -------------------> |         | ------------> Format 2
Format 3 ------------> | SCIF | -------------------> | SCIF^-1 | ------------> Format 3
Format 4 ------------> |      | -------------------> |         | ------------> Format 4
Format 5 ------------> |      | -------------------> |         | ------------> Format 5
Format 6 ------------> |      | -------------------> |         | ------------> Format 6
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Fig. 1 Format conversion through SCIF

Proposal:

Using artificial test video sequences, several formats of original video sequences with identical contents can be produced. After the format conversion, e.g., Format i → SCIF → Format j, the converted picture can be compared with the original picture of the same format (Format j) and SNR is calculated.

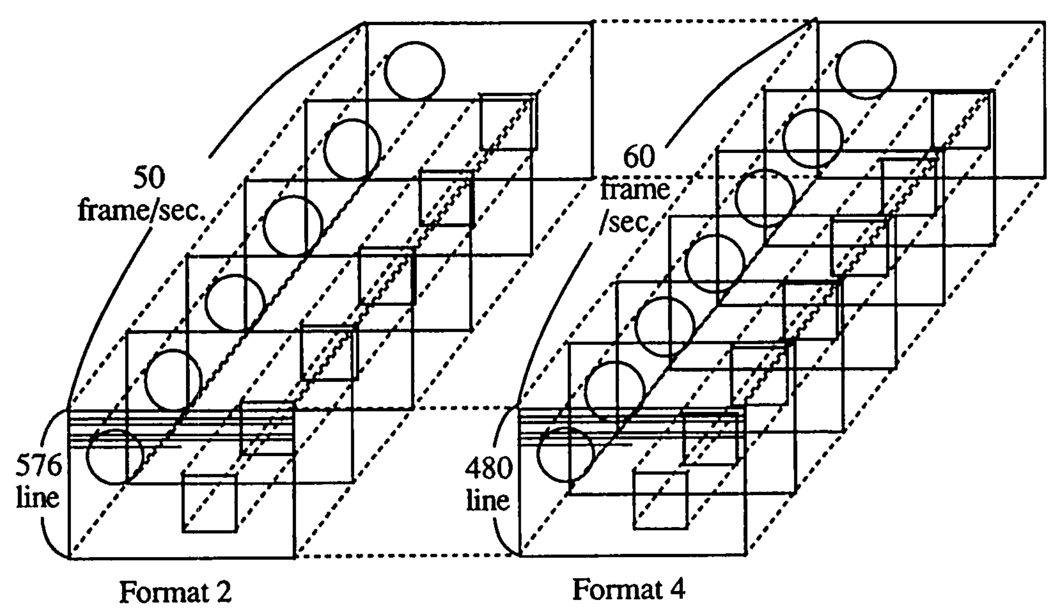

Fig. 2 Process of producing artificial test video sequences

Different format test sequences with identical contents can be provided by spatially and temporally digitizing a continuous artificial picture such as a CG picture (Fig. 2).

We should specify a common artificial picture as one of the test sequences for SCIF (as an option).

This proposed scheme provides us the following advantages.

Advantages:

- Objective evaluation is possible for the picture format conversion.
- Test common format with neutral signal property against 525/60 and 625/50 can be obtained.
- Variation of picture formats can be extended.
- Picture quality can be compared with ones obtained by other conversions such as a conversion without SCIF.

We should, however, note some points such as :

Attention:

- It is desirable that an artificial test sequence should have similar signal properties as natural video sequences.
- This objective evaluation should be used as a supplementary criteria of subjective evaluation.
- Picture format conversion filter will not be specified in the standard.

3. Examples of artificial test sequence and objective evaluation

Two artificial sequences for 1 second were produced and used for the objective evaluation of picture format conversion. Sequence 1 is a monochrome picture, "Moving Circular Zone Plate". Sequence 2 is a CG picture, "Regular Icosahedron". We should note that these are only examples and improvement for better test sequence is necessary.

Results of conversion for both test sequences are shown in Table 2 and 3. In these format conversions the following three different conversions are involved.

(1) line number conversion (5 ↔ 6 conversion) by 9/11 tap filter (AVC-80 ANNEX2)

(2) frame rate conversion (5 ↔ 6 conversion) by 9/11 tap filter (AVC-80 ANNEX2)

(3) interlace ↔ progressive conversion by line insertion (16 tap filter) and line skipping

16 tap filter : (-6.392597E-6, 1.106411E-4, -9.153038E-4, 4.847720E-3, -1.869835E-2, 5.759092E-2, -1.599748E-1, 6.170455E-1, ...(symmetrical))

Table 2 and 3 shows that conversion including frame rate conversion or interlace → SCIF (candidate) → progressive conversion may need some improvement.

Table 2 Results of picture format conversion for Moving Circular Zone Plate (Y signal only)

Output / Input	Format 1	Format 2	Format 3	Format 4	Format 5
Format 1	42.74 dB	18.40 dB	16.22 dB	16.22 dB	18.41 dB
Format 2	41.70 dB	41.70 dB	18.20 dB	18.20 dB	45.64 dB
Format 3	16.00 dB	16.00 dB	44.55 dB	19.13 dB	15.41 dB
Format 4	17.49 dB	17.49 dB	43.48 dB	43.48 dB	17.43 dB
Format 5	46.88 dB	46.88 dB	18.18 dB	18.18 dB	X

Table 3 Results of picture format conversion for Regular Icosagedron (Y signal only)

Output / Input	Format 1	Format 2	Format 3	Format 4	Format 5	Format 6
Format 1	56.27 dB	43.64 dB	40.10 dB	40.09 dB	42.17 dB	44.54 dB
Format 2	56.04 dB	56.04 dB	41.55 dB	41.55 dB	45.88 dB	45.79 dB
Format 3	40.01 dB	40.00 dB	54.04 dB	43.27 dB	40.19 dB	43.49 dB
Format 4	41.39 dB	41.40 dB	53.97 dB	53.97 dB	42.85 dB	47.64 dB
Format 5	47.66 dB	47.66 dB	43.47 dB	43.47 dB	X	—
Format 6	35.49 dB	34.83 dB	34.97 dB	34.97 dB	38.52 dB	38.52 dB

4. Conclusion

We proposed an objective evaluation scheme for picture format conversion, and also proposed that some artificial test sequences should be added to the common test sequences.

End.