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

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Title: Comparison of Picture Quality and Encoding Efficiency between SCIF (Super CIF) and Interlaced Format Using MPEG Encoding

Purpose: Information

1. Introduction and Background

At the Paris meeting, the proposal were made that the SCIF be specified for the purposes of providing high-quality pictures. The meeting also addressed problems of picture quality deterioration and a decrease in the encoding efficiency due to conversion from the existing format to the SCIF.

We assumed the following conditions for the SCIF and studied picture quality deterioration and a decrease in the encoding efficiency occurring when pictures are encoded by the MPEG algorithm.

Number of horizontal pixels: 720
Number of vertical pixels: 576
59.94 frames/sec (Progressive format)

2. Study of Encoding Efficiency and Picture Quality

(1) Conditions

① Encoding conditions

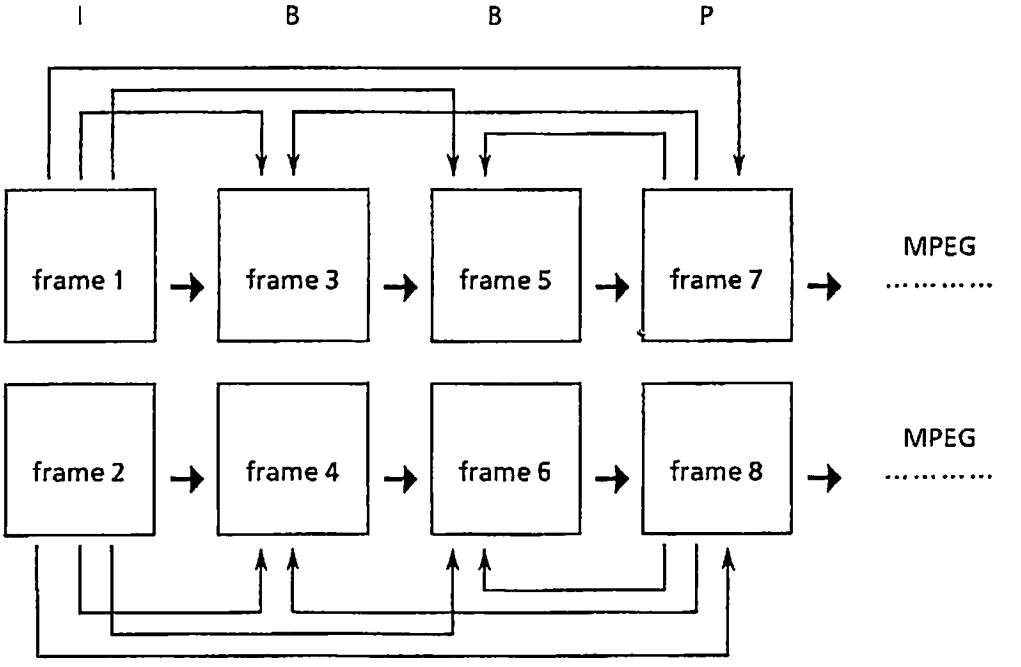
Sequence: Flower garden, and Mobile and calendar

Algorithm: MPEGex (N = 15, M = 3)

② Prediction architecture and parameters

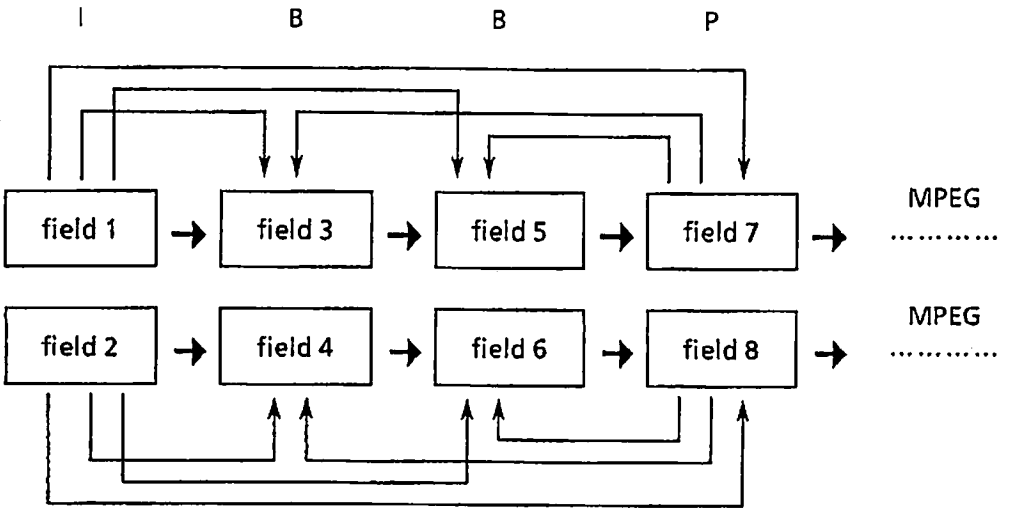
SCIF: Number of pixels: 720 × 576, 4:2:0

59.94 frames/sec (Progressive scanning)



ILF (Interlaced format): Number of pixels: 720 × 240, 4:2:0

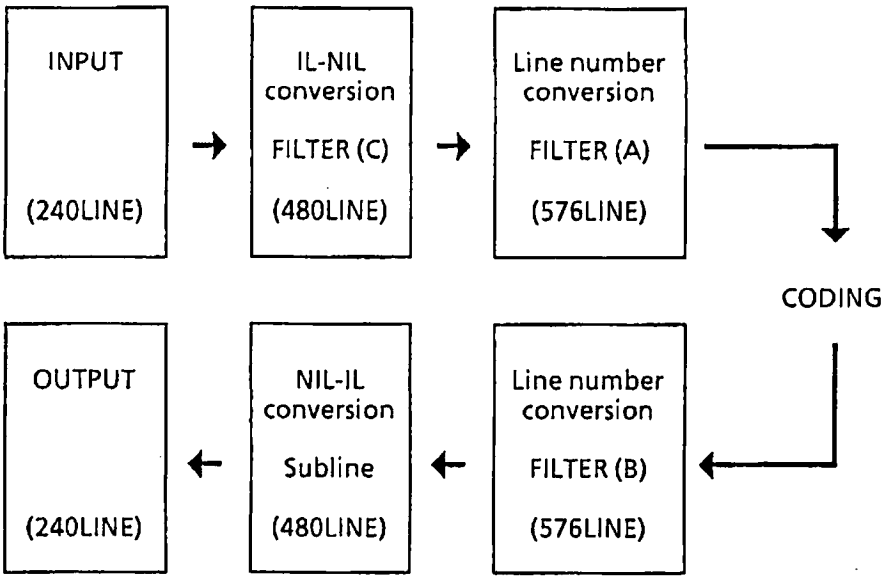
59.94 fields/sec (Interlaced scanning)



③ The following equation was used to calculate the S/N ratio.

$$SNR = 20 \log_{10} \left(\frac{255}{RMSE} \right) \quad (db)$$

④ Parameters for SCIF conversion

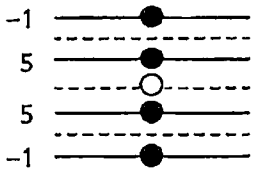


* Filter (A) 480 → 576 Conversion filter
  9 taps (See Filter #2 in AVC-80 Annex.)

* Filter (B) 576 → 480 Conversion filter
  11 taps (See Filter #4 in AVC-80 Annex.)

* Filter (C) Up-sampling filter
  4 taps (-1 5 5 -1)

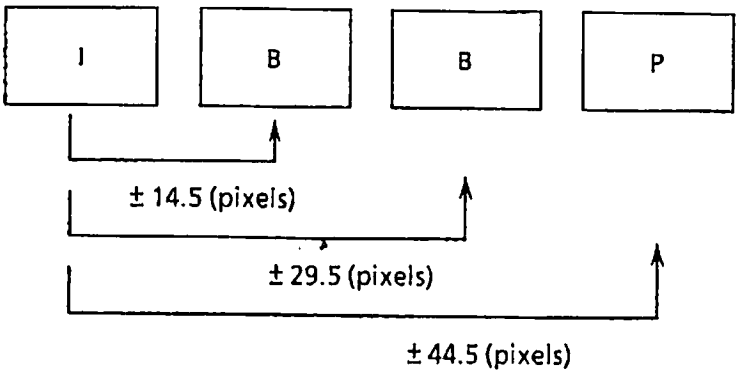
Using the figure on the right, one "black" data value is prepared from four "white" data values.



⑤ Method for rate control

Picture quality is optimized by storing N pictures (N = 15) of frame types I, P, and B in memory, measuring their entropy, and assigning bits to the pictures according to the entropy ratio. While maintaining the entropy ratio, coding is done by determining the Q factor so that the rate is 4Mbps. To reduce block noise in both SCIF and ILF formats, a pre-filter was operated so that the S/N ratio was decreased by 1.5 db at a fs/2 point.

⑥ Motion vector search range (Monitor compensation was made using a 16-pixel × 16-pixel macroblock.)



* MPEG1 defines the Q factor as follows.

INTRA

dct_recon [m] [n] = (2 × dct_zz [i] × Q × intra_quant_mx [m] [n])/16

INTER

dct_recon [m] [n] = (((2 × dct_zz [i] + Sign (dct_zz [i])) × Q × inter_quant_mx [m] [n])/16

where $\mathrm{Sign}(x) = \begin{cases} 1 & x > 0 \\ 0 & x = 0 \\ -1 & x < 0 \end{cases}$

⑦ Quantization matrix

SCIF INTRA

8,	16,	19,	22,	26,	27,	29,	34,
16,	16,	22,	24,	27,	29,	34,	37,
19,	22,	26,	27,	29,	34,	34,	38,
27,	29,	35,	38,	46,	56,	69,	83,
36,	39,	48,	51,	62,	75,	93,	112,
45,	49,	61,	64,	78,	94,	117,	141,
54,	59,	74,	77,	94,	113,	141,	170,
64,	69,	84,	91,	110,	134,	165,	199,

INTER

16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,

ILF INTRA

8,	16,	19,	22,	26,	27,	29,	34,
16,	16,	22,	24,	27,	29,	34,	37,
19,	22,	26,	27,	29,	34,	34,	38,
22,	22,	26,	27,	29,	34,	37,	40,
22,	26,	27,	29,	32,	35,	40,	48,
26,	27,	29,	32,	35,	40,	48,	58,
26,	27,	29,	34,	38,	46,	56,	69,
27,	29,	35,	38,	46,	56,	69,	83,

INTER

16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,
16,	16,	16,	16,	16,	16,	16,	16,

(2) Encoding efficiency test

Using the parameters mentioned above, encoding was done going the same quantization steps (Q = 8, g = 16) in both the SCIF and ILF formats. The results are shown below. The S/N ratio of pictures only converted to the SCIF format was 44.2 and 43.8 db for F.G. and M.C., respectively.

Sequence (F.G.) Average of data obtained from 15 sample pictures

		Total Number of bits/original field (bits)	Number of bits/original field (bits)	Y S/N (db)
SCIF	I	479884	475011	35.13
	P	276397	260984	35.02
	B	109088	87182	34.13
ILF	I	317288	315159	33.89
	P	209842	203887	33.74
	B	72059	63649	32.68

Since encoding was done after conversion to the SCIF format, the number of bits was increased by 51%, 32%, 51%, for I, P, and B, respectively. (In this case, the S/N ratio was not controlled so that two formats had the same value.)

Sequence (M.C.) Average of data obtained from 15 sample pictures

		Total Number of bits/original field (bits)	Number of bits/original field (bits)	Y S/N (db)
SCIF	I	659176	654310	33.02
	P	377645	363415	33.74
	B	238459	218450	32.73
ILF	I	452256	450132	31.26
	P	275517	270166	32.11
	B	146785	139326	30.96

Since encoding was done after conversion to the SCIF format, the number of bits was increased by 46%, 37%, 62% for I, P, and B, respectively. (In this case, the S/N ratio was not controlled so that two formats had the same value.)

(3) Picture quality test

Using the parameters mentioned above, encoding was done in both the SCIF and ILF formats with the encoding rate set at 4 Mbps. The results are shown below.

Sequence (F.G.) Average of data obtained from 45 sample pictures

		Total Number of bits/original field (bits)	Number of bits/original field (bits)	Y S/N (db)
SCIF	I	241828	236982	28.78
	P	95834	80174	28.46
	B	36214	14902	27.96
ILF	I	226983	224901	29.00
	P	103402	97429	27.94
	B	33142	24912	27.60

The S/N ratio was almost the same for pictures encoded in the SCIF and ILF formats.

Sequence (M.C.) Average of data obtained from 45 sample pictures

		Total Number of bits/original field (bits)	Number of bits/original field (bits)	Y S/N (db)
SCIF	I	264831	259987	25.56
	P	93723	80413	26.01
	B	34810	16639	25.27
ILF	I	228396	226307	25.31
	P	101114	96262	25.91
	B	33843	26980	25.25

The S/N ratio of pictures encoded in the SCIF and ILF formats was nearly the same as in the case of the F.G.

3. Conclusion

Using the MPEG algorithm, a decrease in the encoding efficiency and picture quality deterioration were examined in the SCIF and ILF formats. The data obtained show that the percentage of the increase in the number of codes in the SCIF format is considerably high for a common step size. However, when the number of bits was controlled, the S/N ratio was almost the same for the SCIF and ILF formats.

This is accounted for by the following two reasons.

(1) Since the pixel density of the SCIF format is higher than that of the ILF format, data produced in the DCT block obtained higher compaction with the result that coding efficiency was increased.

(2) A decrease in efficiency due to increased picture area and the efficiency increase mentioned above canceled each other, so that the S/N ratio was almost the same for the SCIF and ILF formats.

However, it is necessary to study various characteristics of the SCIF format including the characteristics of the quantization matrix and the visual characteristics of pictures as moving ones.

The data shown above were obtained in the process of studying the SCIF and ILF characteristics. We will make every effort to further study the SCIF and ILF formats.