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SOURCE: Japan
TITLE: Comparison of Prediction Methods of the Low Delay Mode of TM1.
PURPOSE: Discussion

INTRODUCTION This paper provides an analysis and comparison of several different types of prediction methods of the *low delay mode* of TM1. In the first experiment, four different types of frame based methods are analysed. In the second experiment, Method A from Experiment 1 is compared against two pure field methods. Finally, in the last experiment, the increased performance of half pel motion vector searching on reconstructed picture is measured.

EXPERIMENT 1 Figure 1 shows that SNR of the Field Adjusted Motion Compensation (FAMC) (method C) is 1.5dB higher than the SNR of the field/frame adaptive method (method A) in the low delay mode (M=1). By comparing to M=3, it was found that FAMC was more effective in the low delay mode. At first, it was presumed that by using field, frame, dual, FAMC method (method D) together, the results produced would be far superior to the other three methods. However, experimentation has shown that method D is approximately the same as method C.

Method A. field/frame
Method B. field/frame/dual
Method C. FAMC
Method D. field/frame/dual/FAMC
(See ANNEX 2 for detail.)

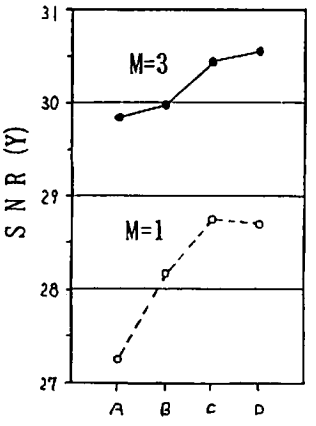


Fig.1 Comparison of Prediction Methods. (data#1)

EXPERIMENT 2 In this experiment, we examined the effectiveness of the pure field prediction which can be achieved with low delay (see ANNEX 1). Figure 2 indicates that the SNR of the pure field prediction method (method B) is a little greater than 1 dB above the SNR of the frame based prediction method (method A).

Method A. field/frame,M=1,N=150
Method B. pure field ,M=3,N= 30
Method C. pure field ,M=1,N=150
(See ANNEX 2 for detail.)

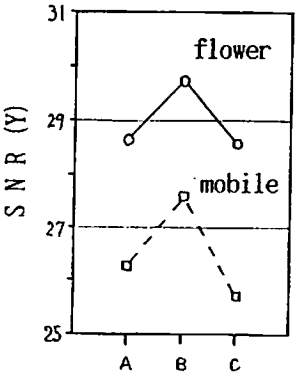
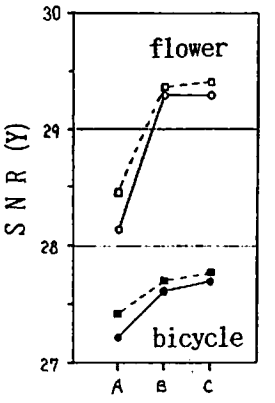


Fig.2 Comparison of Prediction Methods. (data#2)

EXPERIMENT 3 In the hope of further improving picture quality, we compared the SNR of a picture which used the half pel MV searching technique on the reconstructed picture versus the SNR of a picture which did not incorporate this technique. Figure 3 shows that if this method is realized a higher SNR can indeed be obtained.

Method A. field/frame
Method B. field/FAMC
Method C. field/frame/FAMC
(See ANNEX 2 for detail.)



□, ■ on the reconstructed picture

○, ● on the original picture

Fig.3 Comparison between two MC Methods. (data#3)

CONCLUSION In this paper, we compared some prediction methods on low delay mode which are becoming a necessary feature in real time communication system. The results from this experiment which are based on signal noise ratios can be used to form a judgement on which method is the best one to implement. In comparison to the other frame based methods, FAMC produced better results, however, further consideration in respect to hardware complexity and other factors is still needed. In addition, the results has shown that it would be wise to continue researching in the area of pure field prediction method. Finally, it was shown that the image quality can be increased by using half pel MV searching technique.

End.

Annex 1

The amount of delay is calculated as follows.

The amount of delay[1]. [msec]

	coding/decoding delay	field mergin delay	buffering delay[max][2]		total delay	
			A[3]	B[4]	A[3]	B[4]
Fr/fi adaptive	0	33 (2field)	112.5	182	145.5	215
pureFi (M=3, Bref. 2)	50 (3field)	0	62.5	101	112.5	151
pureFi (M=1)	0	0	62.5	101	62.5	101

1) In the case of 1.8 Mbps, VBV buffer is 327 kbits in MPEG 1 with constrained bit. This implies that VBV is 727 (=4/1.8x327) kbits in 4 Mbps.
2) Frame based coding's delay costs approximately 1.8 times of field based coding's one. This value has been obtained in our experiance keeping the same quality between picture of frame based coding and that of pure field coding.
3) This values are obtained through experiments with the following equation.
buffering_delay = mumber_of_bits_for_INTRA_picture / bit_rate
(See AVC-275:annex 2 for detail.)
4) Assuming the VBV buffer as the maximun number of bits, the buffering delay of the frame based coding is limited to 182 msec.

Annex 2 The data from several companies is summarized below.

Simulation Results

rate control	M	N	prediction	SNR(Y) (U) (V)	SNR(Y) (U) (V)	
				Mobile (60frame)	Football (60frame)	
TM1 (step1-2)	1	150	field/frame	[I] 25.84 32.28 32.35	[I] 33.09 39.06 40.14	data #4
				[P] 26.75 32.08 32.03	[P] 30.95 34.94 36.50	Company 4
				Mobile (150frame)	Flower (150frame)	
TM1 (step1-2)	1	150	field/frame	24.42 30.50 30.32	25.18 29.93 32.14	data #5
			fd/fr/dual	24.32 30.29 30.12	25.18 29.83 32.07	Company 5
				Mobile (60frame)	Flower (150frame)	
TM1 (step1-3)	1	15	field/frame	25.65	27.25	data #1
			fd/fr/dual	25.96	28.17	Company 1
			FAMC	25.88	28.74	
			fd/fr/du/FAMC	26.09	28.71	
				Mobile (60frame)	Flower (60frame)	
TM1 (step1-2)	1	150	field/frame	26.25	28.65	data #2
	3	30	pure field	27.59	29.76	Company 2
	1	150	pure field	25.72	28.60	

rate control M N
TM1 (step1-3) 1 150

data #3
Company 3

SNR(Y) [dB]

	Fi/Fr		FAMC	Fi/FAMC		Fi/Fr/FAMC	
	ORG-ORG	ORG-REP		ORG-ORG	ORG-REP	ORG-ORG	ORG-REP
	28.13	28.43	29.28	29.28	29.37	29.30	29.40
FG	27.64	27.98	28.72	28.74	28.83	28.76	28.87
	25.81	26.22	25.97	26.05	26.34	26.08	26.43
M&C	25.94	26.62	26.06	26.16	26.71	26.18	26.81
	31.05	31.28	31.22	31.25	31.32	31.33	31.45
FB	30.59	30.83	30.95	30.98	31.04	31.04	31.14
	27.21	27.42	27.62	27.62	27.69	27.68	27.75
BIC	27.48	27.73	27.88	27.88	27.98	27.94	28.04

note1) Upper column is for 60frame and lower column is for 150frame
note2) ORG-ORG represents half pel refinement on original image, while ORG-REP represents half pel refinement on local decoded image. But, half pel MV of FAMC is always obtained from original images.

Annex 3 A D1 tape demonstration is available to see degree of picture quality. The contents of the demonstration is as below.

Demo.#1 sequence:flower garden

prediction	sec.	company#
fr/fi adaptive (M=1)	5	3
fr/fi adaptive (M=1)	2	2
fr/fi/FAMC (M=1)	5	3
pure-fi (M=1)	2	2
pure-fi (Bref.2, M=3)	2	2

Demo.#2 sequence:mobile&calender

prediction	sec.	company#
fr/fi adaptive (M=1)	5	3
fr/fi adaptive (M=1)	2	2
fr/fi/FAMC (M=1)	5	3
pure-fi (M=1)	2	2
pure-fi (Bref.2, M=3)	2	2