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SOURCE : JAPAN
TITLE : CODING EFFICIENCY OF LEAKY PREDICTION
Purpose : Information

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1. Introduction

Leaky prediction can potentially contribute to improving error resilience, channel hopping and low delay characteristics. It may help us to make the coding algorithm simple and generic.

This contribution describes experimental results on the leak factor dependency of the coding efficiency to understand basic characteristics of the leaky prediction as defined in Core Experiment No.6 of TM2 (p.148 of AVC-323, MPEG92/N0245).

2. Simulation Method

A modified version of CCITT RM8, thus different from TM2 in details, is used for this experiment.

1) Source format	4:2:2; the first 20 frames are coded
2) Data structure	4 blocks (Y1,Y2,Cr,Cb)/MB; 1MB-line/slice
3) Temporal redundancy	
- Coding structure	I,P,P,P... (M=1, N >> 1)
- Prediction mode	non-adaptive frame prediction
- Motion compensation	+/-14.5 pels horizontal by +/-10.5 pels vertical with half pel accuracy
4) Spatial redundancy	non-adaptive frame DCT coding
5) Quantization	without weighting matrices
6) Entropy coding	one 2-d VLC for non-intra DC components with 3 bit EOB
7) Coding control	open loop with fixed step size
8) Statistics	averaged over 19 INTER coded pictures

3. Information Generation

The number of bits generated per frame is plotted in Figure 1 against the leak factor, where "inf" indicates the case of LF=1 and "0" indicates the first INTRA frame. We can observe as follows;

1) Information generation increases gradually for LF=1-1/64, 1-1/32, 1-1/16 but starts to rapidly increase from LF=1-1/8. This tendency applies to all the four sequences.

2) Coding efficiency of the leaky prediction generally lies between those of the non-leaky INTER coding and INTRA coding. For the Football sequence containing rapid motion, however, leaky prediction with LF=1-1/2 requires more bits than INTRA coding, showing that for some macroblocks INTER coding (sending DCT coefficients for the prediction error and motion vectors) is less efficient than INTRA coding (sending DCT coefficients for the original signal).

3) The leaky prediction loses coding efficiency to some extent, but it may be compensated by not needing periodic whole INTRA pictures to provide for random access capability. Let k be the ratio for number of bits per frame for INTRA and INTER, and N be the number of frames per GOP. The leaky prediction can consume more bits as given by;

$$a = (N-1+k)/N = 1+(k-1)/N,$$

which is a yardstick to evaluate coding efficiency of the leaky prediction. Larger values of k and/or smaller values of N allow larger leak factors.

The experimental data are as follows;

Sequence	Step size	Measured SNR LF=1	Measured SNR LF=1/2	Measured k	Calculated 1+(k-1)/12	Measured increase for LF= 1-1/64	1-1/32	1-1/16
mbcl	8	36.1	36.6	2.18	1.098	1.035	1.055	1.094
	14	31.8	32.1	2.51	1.126	1.050	1.081	1.134
	20	29.3	29.4	2.79	1.149	1.064	1.102	1.179
	26	27.6	27.5	3.04	1.184	1.076	1.123	1.218
flow	8	37.1	37.7	2.21	1.101	1.044	1.060	1.096
	14	33.1	33.5	2.54	1.128	1.061	1.088	1.140
	20	30.8	30.9	2.80	1.150	1.071	1.105	1.175
	26	29.1	29.0	3.02	1.168	1.080	1.122	1.207
foot	8	37.2	37.4	1.33	1.028	1.032	1.037	1.061
	14	33.8	33.9	1.42	1.035	1.049	1.057	1.089
	20	31.8	31.8	1.50	1.042	1.057	1.066	1.104
	26	30.3	30.4	1.60	1.050	1.065	1.074	1.119
ssie	8	39.3	39.4	3.53	1.211	1.436	1.511	1.657
	14	37.1	36.9	5.58	1.382	1.719	1.861	2.145
	20	35.8	35.4	7.25	1.521	1.815	1.986	2.339
	26	34.9	34.3	8.63	1.636	1.830	2.012	2.423

From these statistics, we can see that MBCL and FLOW allow LF=1-1/16 or 1-1/32, thus leaky prediction is competitive, while leaky prediction loses coding efficiency a little for FOOT and significantly for SSIE.

4) Selection of leak factor will be determined as a trade-off between coding efficiency and speed of recovery from an errored or mismatch sate. The necessary number of cycles in the decoder is shown for a given error to disappear (or converge to 128) in Annex, assuming zero input to the leaky predictive decoder.

4. Coding Mode

Figure 2 shows macroblock distributions when the step size is 20. We can see that for LF=1-1/8 or larger, intra macroblocks outstandingly increase. This corresponds to the rapid increase of information generation described in Section 3 above. It is also observed that fixed macroblocks significantly decrease for leaky prediction.

5. Coded Pictures

Coded pictures of the Flower Garden sequence have been recorded for LF=1-1/16 and 1-1/2. The demonstration tape shows the following four pictures;

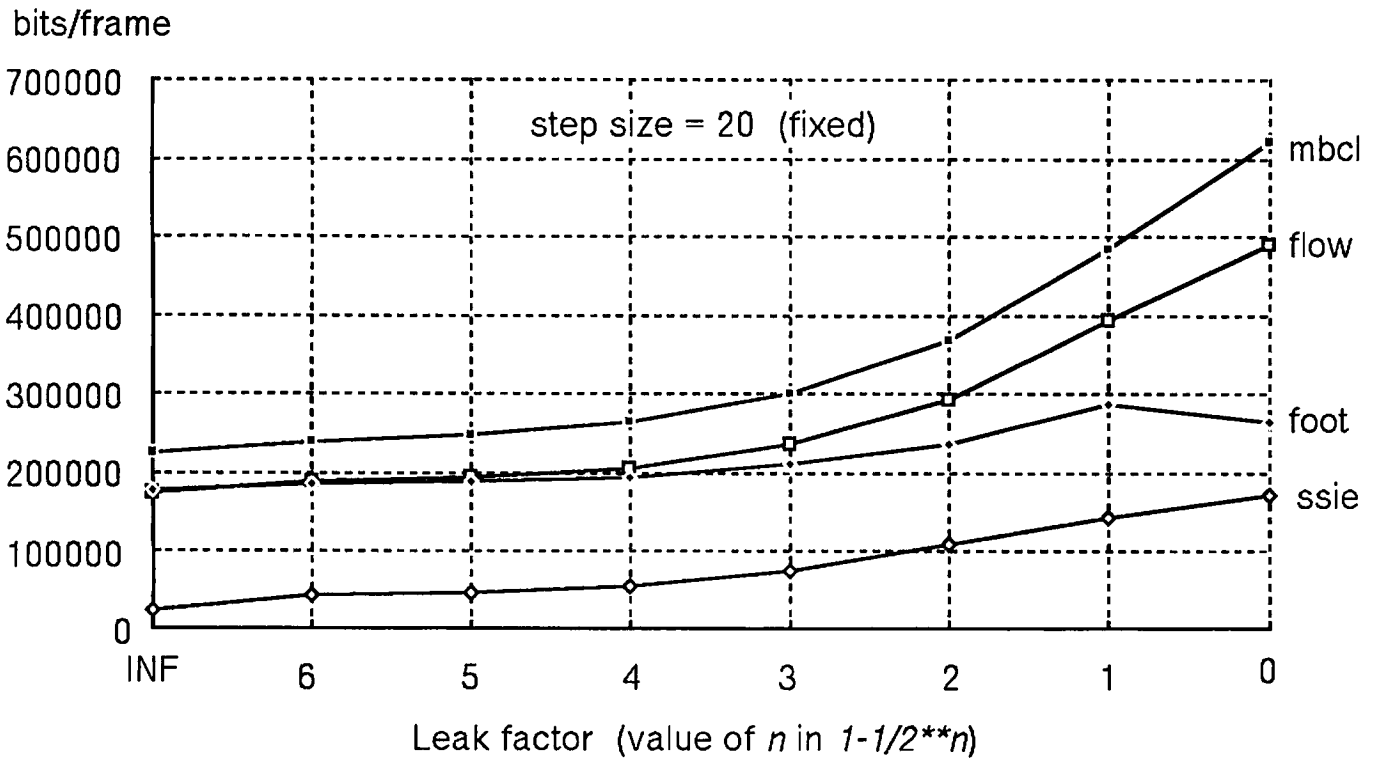
1) original
2) LF=1
3) LF=1-1/16
4) LF=1-1/2.

For LF=1-1/16, background parts (sky) become busy, perhaps due to (MC) inter coding instead of fixed coding. For LF=1-1/2, however, the background parts become steady but blocky, perhaps due to intra coding. It is noted that both cases show SNR values very close to that of the non-leaky case. Adaptive quantization would solve the problem. For the flower parts, difference between non-leaky and leaky predictions looks small.

6. Conclusion

Coding efficiency of the leaky prediction has been measured by a simulation experiment. If we can find a means to remove artifacts peculiar to leaky prediction, such as busy or blocky backgrounds, it will contribute to making the coding algorithm simple and robust, hence generic.

END



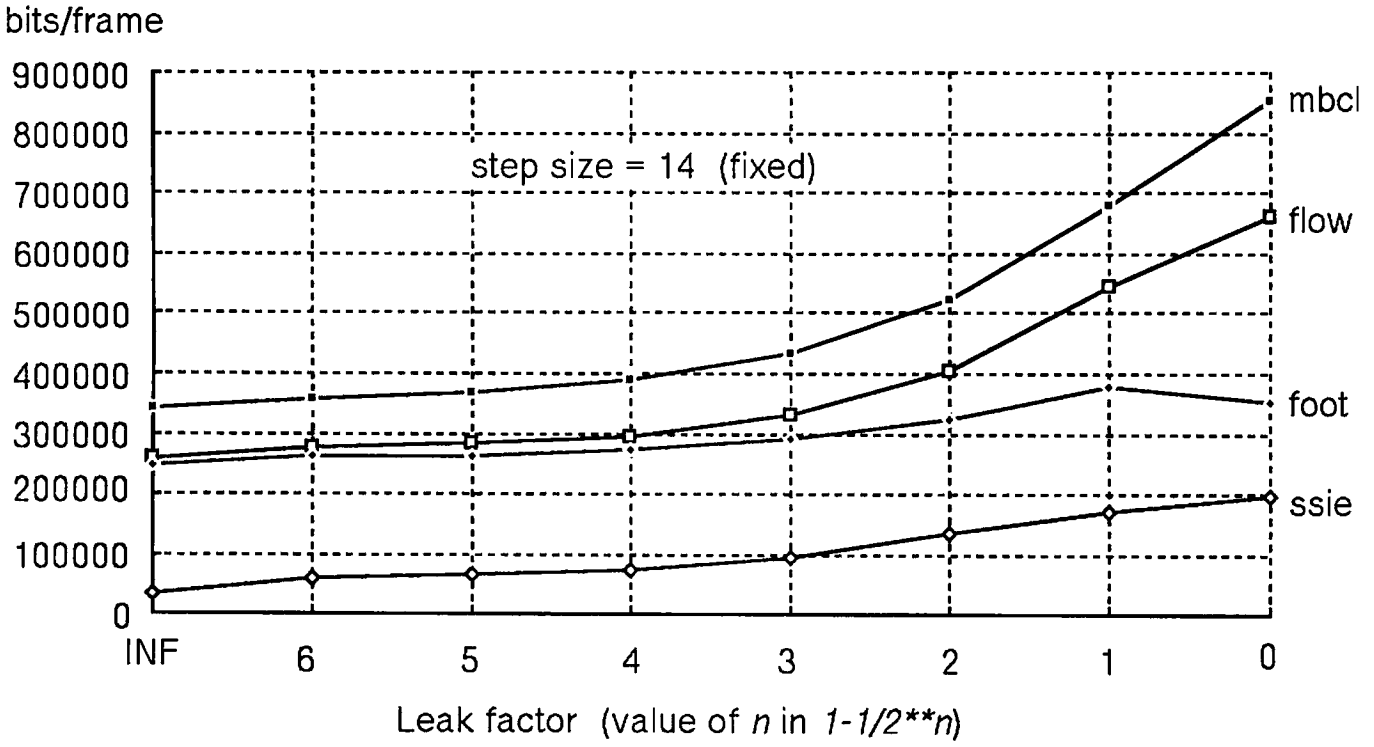


Figure 1 Coding efficiency

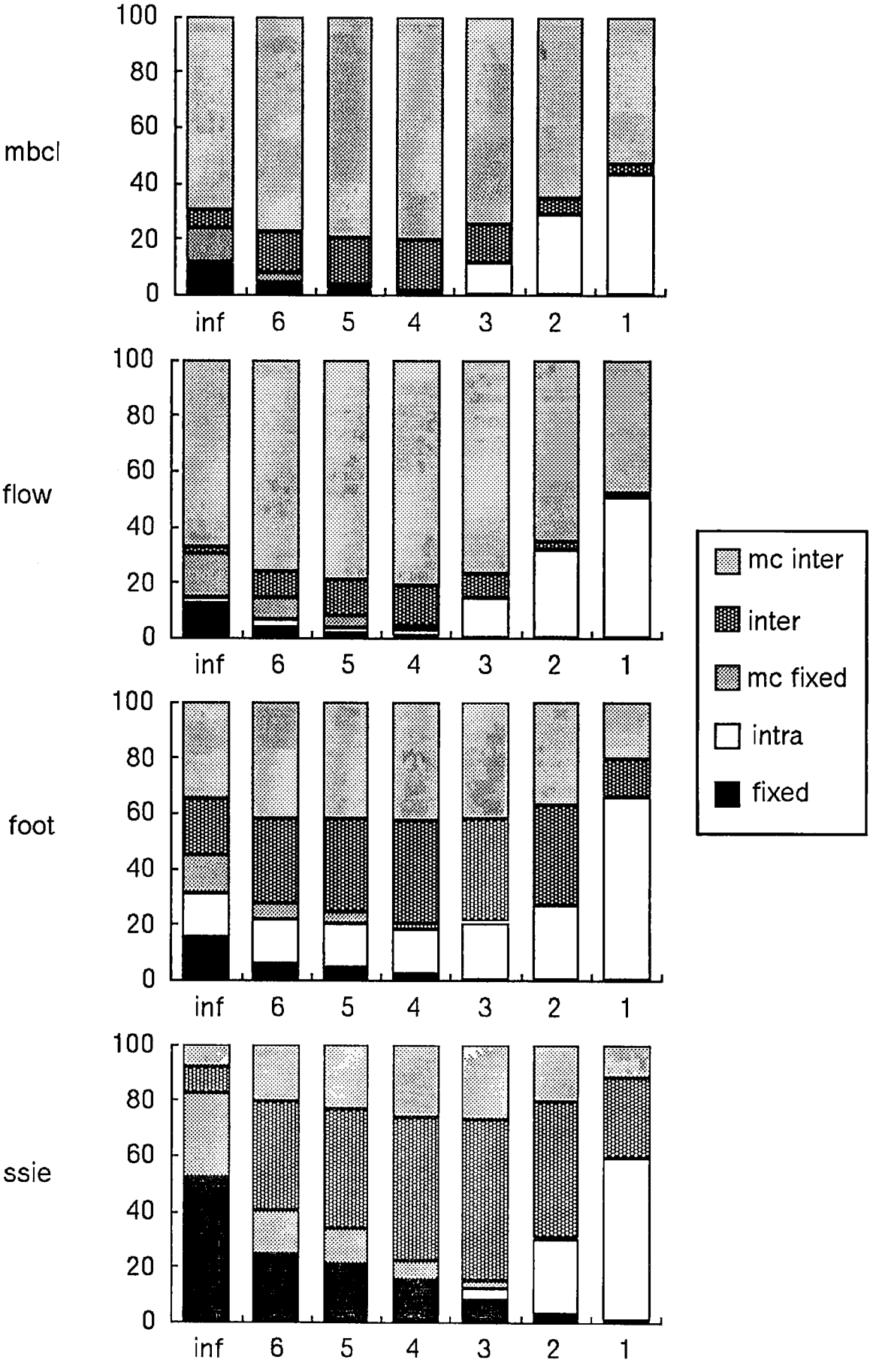


Figure 2 Mcroblock Type

Annex to AVC-331

Recovery time for the error to become zero