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SOURCE : Japan
TITLE : Effect of pseudo-random signal insertion in leaky prediction
PURPOSE : Information

1. Introduction

It has been pointed out that insufficient precision in leaky factor calculation causes limit cycle effect. To solve the problem, a countermeasure was proposed (AVC-349, MPEG92/493). In this document, the effectiveness of the scheme and the effect on the coding efficiency were evaluated through computer simulation.

2. Computer simulation

Three experiments were performed as follows to evaluate the proposed solution (Solution 2 in AVC-349).

Experiment 1 (see Annex 1)

Solution 2 was installed into an RM8 based coding algorithm with open loop control. The results show that the solution gives very little effect on coding efficiency, however, is no help for the "noisy background problem".

Experiment 2 (see Annex 2)

Solution 2 was installed into a TM2 based coding algorithm with low delay mode (M=1). According to the results, the maximum degaradation in SNR due to the insertion of pseudo-random noise is only 0.08 dB. The difference was not recognized in the subjective evaluation of the reproduced picture (Flower Garden and Mobile & Calendar). However, the doccument also pointed out that the "noisy background problem" still exists. The effectiveness of the solution to eliminate the limit-cycle problem was confirmed by a case with channel hopping in still picture.

Experiment 3 (see Annex 3)

Solution 2 was installed into TM2 low delay mode (M=1) and evaluated for Fountain and Flower Garden. According to the results, the maximum degaradation in SNR for luminance signal is 0.02 dB. The effectiveness of the solution to eliminate the limit-cycle problem was confirmed.

To solve the oscilation (noisy background) problem, a DC/AC weighting method was also investigated. The method solve the problem in some degree, however, accompanies some loss in coding efficiency.

3. Conclusion

The proposed solution for the limit-cycle problem was evaluated through computer simulation. According to the results, the solution serves the purpose and the loss in coding efficiency is negligible. However, the "noisy background problem" still exists and need further for applying leaky prediction.

Annex 1 to AVC-358

An experiment on the leaky prediction with the limit cycle fix

1. Coding model

An open loop coding experiment has been carried out using the model described in AVC-331 (MPEG92/471).

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 of 20
8) Test Sequence	Flower Garden

2. Parameters for leaky prediction

1) Prediction scheme	as described in Core Experiment No.6 (TM2)
2) Leak factor	15/16
3) Limit cycle fix	as described in Section 2.2/AVC-349 with correction to Figure 3(b), replacing bt with (1-alpha)*bt
4) Function Tn	truncation toward 128

3. Statistics

Luminance SNR and number of bits per picture averaged over 149 INTER coded pictures are as follows;

	SNR(dB)	bits/picture
without leak (lf=1)	30.34	173863
without the limit cycle fix (bt=0)	30.29	205372
with the limit cycle fix (bt=0 - 15)	30.30	205012

The limit cycle fix has no impact on the coding efficiency.

4. Observation of processed picture

There is no difference of impression between pictures with and without the limit cycle fix, implying that another fix is necessary to solve the "noisy background " problem of the leaky prediction. D1 demonstration is accompanied.

5. Conclusion

If the limit cycle fix is included, the leaky prediction described in Core Experiment No.6 gives a solution for graceful channel hopping, error/cell loss resilience, alternative to cyclic refresh for IDCT mismatch. A remaining problem is the noisy background.

Annex 2 to AVC-358

Evaluation of Solution 2 in AVC-349

1. Introduction

To solve the limit cycle problem in leaky prediction, a countermeasure was proposed (AVC-349, MPEG92/493). In this document, the effectiveness of the scheme and the effect on coding efficiency were evaluated through computer simulation.

2. Computer simulation

The proposed solution was installed into TM2. The simulation conditions were as follows:

- Picture format : 4:2:0
- GOP structure : M=1, N=150 (IPPPP....)
- Picture structure : Frame picture
- Prediction method : Adaptive frame/field
- Leak factor : $0.9375(1-1/2^4)$
- Precision in leakage culculation : 8 bit (truncation)

Table 1 shows the simulation results for Flower Garden and Mobile & Calendar, with and without the solution. Figure 1 shows the SNR fluctuation for each case at 4 Mb/s. According to the results, the maximum degradation in SNR due to the insertion of pseudo-noise signal is 0.08 dB at 4 Mb/s and 0.03 dB at 9 Mb/s and almost negligible. In the subjective evaluation of the reproduced picture, no significant difference can be seen.

The effectiveness of the solution to eliminate the limit-cycle problem was also confirmed using a case with channel hopping in still picture (Decoder starts from DC value of 128). Some of the reproduced pictures will be demonstrated by VCR at the meeting.

3. Conclusion

The proposed solution for the limit-cycle problem was evaluated through computer simulation. According to the result, the solution serves the purpose and the loss in coding efficiency is negligible.

Table 1: Average SNR(dB) in each scheme

Psuedo-random signal insersion	Average SNR (dB)			
	Flower Garden		Mobile & Calendar	
	4 Mb/s	9 Mb/s	4 Mb/s	9 Mb/s
Off	27.89	32.82	25.87	30.38
On	27.81	32.79	25.84	30.36

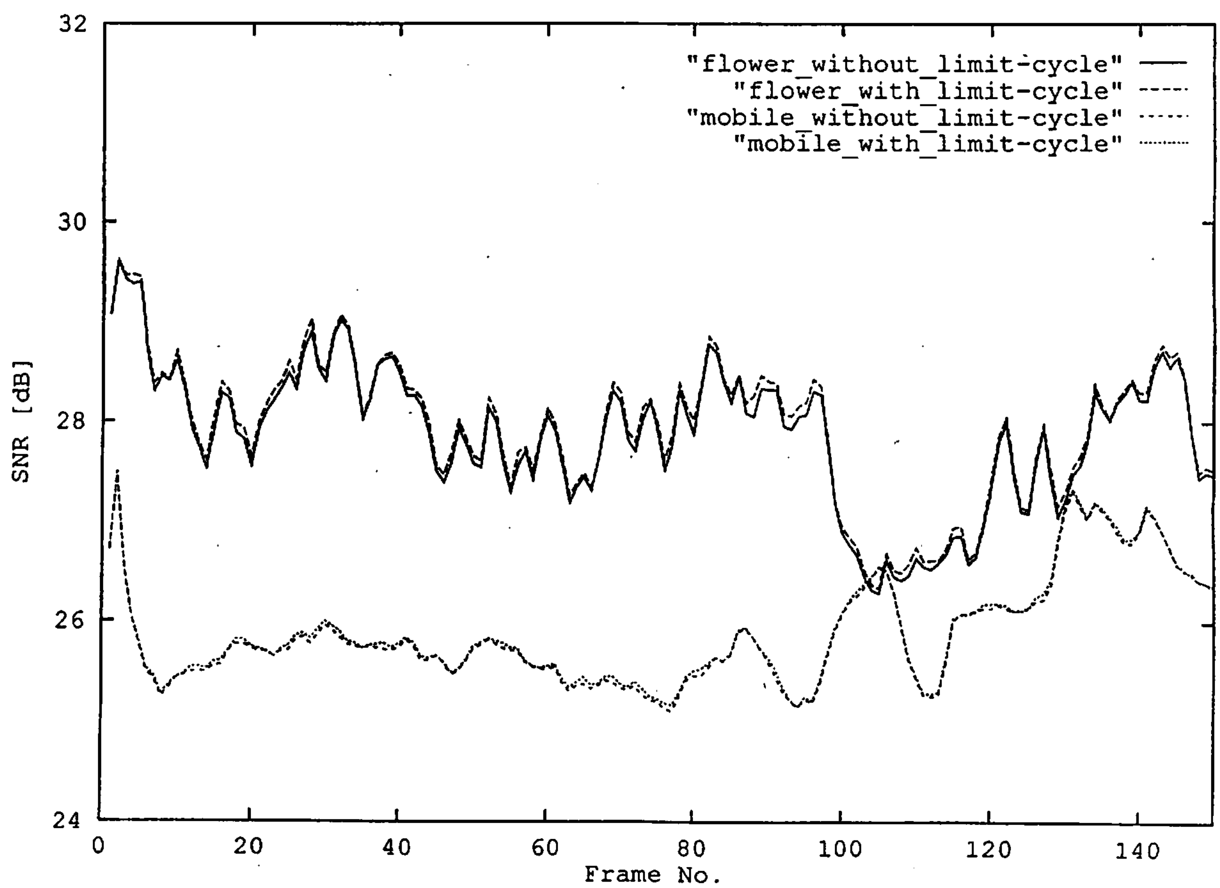

Figure 1: SNR fluctuations with/without Solution 2 (4 Mb/s)

Annex.3

1 Introduction

Leaky prediction causes "limit cycles" when filters in the prediction loop are calculated with integer precision. To solve the problem, Solution 2 was proposed in AVC-349. In this annex, we confirm effect of the solution, and point out another problem of leaky prediction.

2 Effect of Solution 2

We have coded Flower Garden (at 4Mbps) and Fountain (at 2Mbps) with and without the proposed solution. The experiment parameters are based on TM2 frame structure, low delay mode and leaky factor $\alpha = 0.9375$. Results are shown in Table 1. According to the results, the solution has no advantage in SNR. But subjective quality increases because the solution mitigates limit cycles.

Table 1

Sequence	TM2 SNR(dB)	with Solution 2 SNR(dB)
Flower Garden (4Mbps)	28.22	28.22
Fountain (2Mbps)	29.01	28.99

3 DC quantizer

At low bitrate, leaky prediction causes oscillation. To solve the problem, DC quantization method may be changed to keep the DC quantizer step size small.

One solution is that inter DC coefficents are processed as intra DC coefficents. We have coded Flower Garden (at 4Mbps) and Fountain (at 2Mbps) with this solution. The experiment parameters are based on TM2 frame structure, low delay mode and leaky factor $\alpha = 0.9375$. Results are shown in Table 2. According to the results, SNR decreases 1.3dB, but oscillation is not detected.

Table 2

Sequence	TM2		intra DC quantizer	
	SNR(dB)	Coded blocks(%)	SNR(dB)	Coded blocks(%)
Flower Garden (4Mbps)	28.22	71.4	27.40	88.7
Fountain (2Mbps)	28.99	45.2	27.69	69.1

4 Conclusion

Some improvements of DC/AC weighting and quantization method may be required to obtain better subjective performance with leaky prediction. The optimum method will be determined by further study.