

SOURCE : Japan
TITLE : EXPERIMENT ON LOW DELAY MODE
PURPOSE : Information

1. Introduction

INTRA SLICE has been introduced for realizing low delay coding, but it brings two possible problems, namely, (1) the decrease of SNR performance due to less efficient prediction, and (2) the degradation of subjective picture quality by visible movement of INTRA SLICES.

This document shows that the actual SNR performance degradation is small, and the subjective quality can be, while maintaining the minimum delay, largely improved by modifying the rate control algorithm.

2. SNR performance with INTRA SLICES

SNR performance is compared for the two cases with and without INTRA SLICES.

- Source: Flower Garden (#1-#60), Mobile&Calendar (#1-#60).
- Bitrate: 4 Mbit/sec.
- Structure
 - With INTRA SLICES: as TM1 Low delay coding
 - Without INTRA SLICES: $GOP = \{N = 15, M = 1\}$, namely, {IPPPPPPPPPPPPPPP}.

Simulation results are as follows:

Prediction Method	Flower Garden		Mobile&Calendar	
	#1-#60	#31-#60	#1-#60	#31-#60
With INTRA SLICES	27.84	27.79	25.40	25.72
Without INTRA SLICES	28.17	27.93	25.58	25.69

For "Flower Garden", there is a 0.33 dB degradation if averaged over #1-#60, but for the latter half of the same sequence, when rate control becomes more stable, there is only a 0.14 dB degradation. Therefore, we can conclude that there is no significant difference by introducing INTRA SLICES. For "Mobil&Calendar", the degradation is negligible.

However, for some part of the sequences, there is an annoying flicker like degradation due to moving INTRA SLICES, and the rate control method should somehow be improved, as will be discussed in the next section.

3. Rate control method with INTRA SLICES

This section discusses the modification of the rate control method to minimize the visual effect of INTRA SLICES while maintaining the minimum delay.

With the method described in TM1, if the value of the “reaction parameter” r is set to be small, then the rate control can be more adaptive, and the delay necessary to cope with the buffer fullness variation can be made small.

However, when r is set to be too small, the quantization parameter Q can vary significantly within a frame, and the quality difference in the area including and near INTRA SLICES becomes large enough to cause subjectively annoying effect.

Therefore, we experimented two types of modifications for computing d_j in rate control to mitigate the effect of INTRA SLICES.

In TM1 d_j is defined as:

$$d_j = d_0 + B_{j-1} - \tilde{B}_{j-1} \quad (1)$$

$$\tilde{B}_j = T \frac{j}{MBcnt} \quad (2)$$

In the above equation, $\tilde{B}_j$ is a predicted value for B_j , which is assumed to increase constantly with time. However, in Low Delay coding, this assumption does not hold true due to INTRA SLICES.

Therefore, $\tilde{B}_j$ is modified as follows:

- Modification-1: proportional to X_I for INTRA SLICES, proportional to X_P for other slices.
- Modification-2: proportional to $X_{I,j}$ for INTRA SLICES, proportional to $X_{P,j}$ for other slices, where $X_{I,j}$ and $X_{P,j}$ are defined for each macroblock.

To verify the effectiveness of the modified rate control method, simulation was carried out with the following conditions:

- Source: Mobile&Calendar (#1-#60).
- Bitrate: 4 Mbit/sec.

Set ID	Prediction Method	r	$\bar{B}_i$
Set 0	TM1, $N = 15, M = 1$	$2 \frac{\text{bitrate}}{\text{picture rate}}$	TM1
Set 1	Low Delay coding	$2 \frac{\text{bitrate}}{\text{picture rate}}$	TM1
Set 2	Low Delay coding	$0.25 \frac{\text{bitrate}}{\text{picture rate}}$	TM1
Set 3	Low Delay coding	$0.25 \frac{\text{bitrate}}{\text{picture rate}}$	Modification-1
Set 4	Low Delay coding	$0.25 \frac{\text{bitrate}}{\text{picture rate}}$	Modification-2

Simulation results are shown in the Figures on page 4.

Buffer Occupancy

In the Figure, the buffer occupancy is shown as resulting buffer delay and its behavior is largely determined by r . Obviously, Set 0 shows the largest variation due to I frames that occur periodically. Set 1 shows the next largest variation and Sets 2-4 shows the smallest variations, as is expected.

SNR Performance

SNR performances, as they are averaged over one frame period, show the same tendency as the variations of the buffer occupancy, namely, Sets 2-4 shows the smallest fluctuations of SNR values.

Quantizer Scale

However, the quantizer scale varies largely within a frame if we simply use a smaller value of r as in Set 2, which leads to annoying visible INTRA SLICES.

On the contrary, curves for Set 3 and Set 4 shows very small quantizer scale variations within a frame. Among Set 3 and Set 4, the latter gives smaller variations, and thus more preferable than the former.

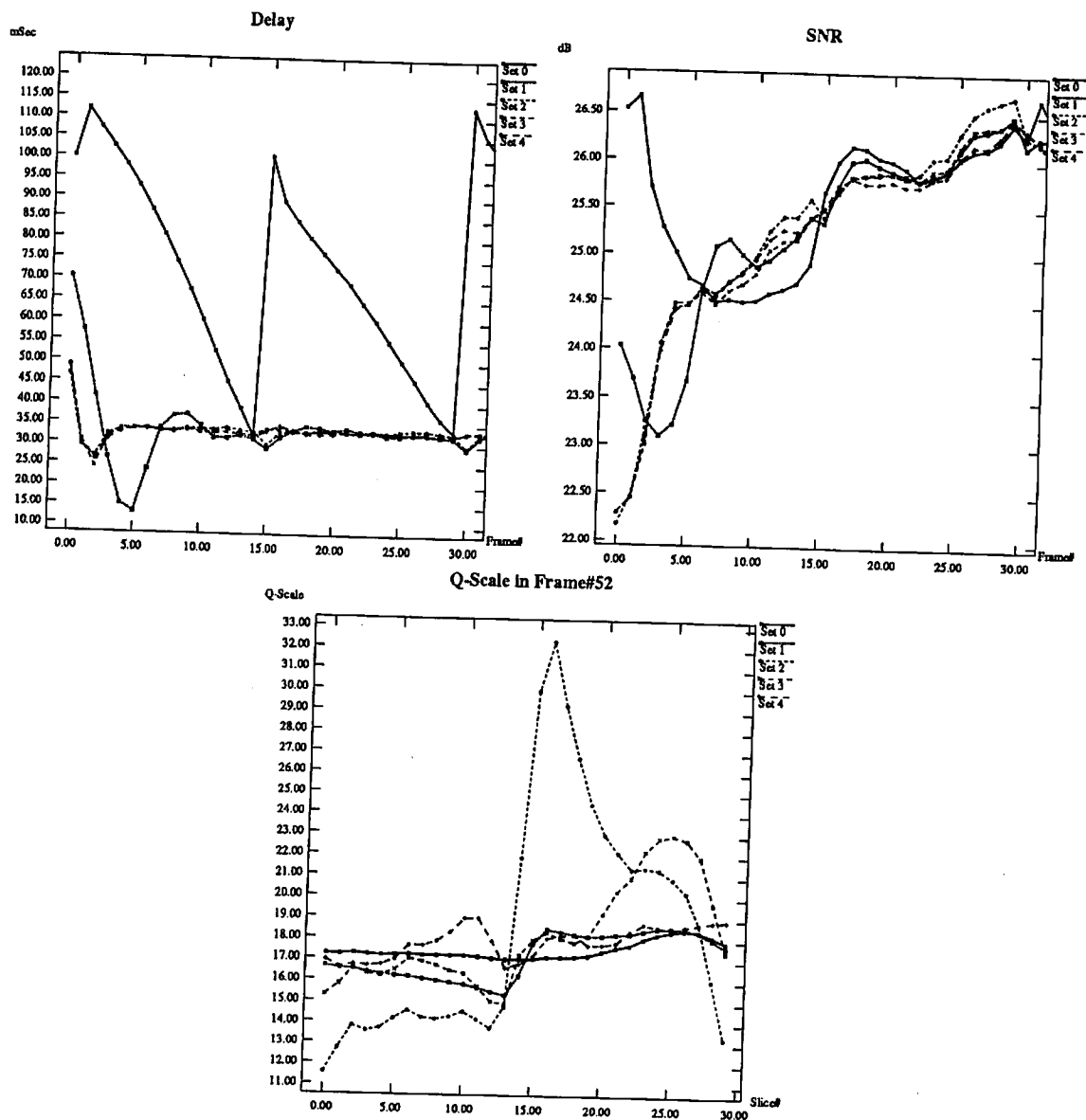
but the Q-scale variation within a frame becomes larger.

4. Conclusion

This document discussed the effects of INTRA SLICES introduced for Low delay coding, and a new rate control method is proposed which optimizes picture quality while taking the delay restriction in account.

Tape Demonstration

A D1 tape is available for demonstrating the visual effect of the proposed rate control method.



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