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1. Introduction

In Nurnberg Meeting 1986, an adaptive use of quantizer characteristics was suggested to avoid or reduce picture quality degradation such as blocking effect due to coarse quantization [Doc # 149].

This contribution briefly describes recent results and discusses appropriate hardware structure for quantizers.

2. Recent Results

(1) Adaptive Quantization of Low Sequency Components

When three different quantizers are applied to coefficients corresponding to three (low, middle and high) sequency groups, no further quality improvement has been observed. This suggests that more than two quantizers are not necessary to quantize transform coefficients in a block. When two different quantizers were employed as in Doc. # 149, picture quality improvement was observed, though not remarkably. In addition, it is very difficult to figure out the improvement e.g. by means of SNR and/or information rate. Subjective improvement is expected in Adaptive Quantizers.

It seems very difficult to achieve optimum use of quantizers solely by computer simulation work, since current test sequences are only a small part of actual situation. To overcome this difficulty, we can take advantage of Flexible Hardware.

(2) Appropriate Relation between Stepsize and Deadzone

For linear quantizer characteristics, relation between stepsize(T) and deadzone(g) can be defined as

$$T = A \times g.$$

In RM3, 'A' equals 1.5.

According to the results when the value of 'A' was changed from 2/3 to 2.5, the value used in RM3 is reasonable on the average. It seems that optimum value for 'A' is not constant and it depends upon input sequences. In Flexible Hardware, deadzone can be quite easily changed without increasing the maximum number of quantizers. In addition, deadzone can be chosen freely without affecting compatibility as long as the correspondence between quantizer output levels and code words in VLC does not changes.

(3) Quantizers for Color Component

According to experiments, it seems that coarse quantization of color component does not necessarily result in color degradation though color information amount was considerably reduced, say, by a factor of five or ten. It may be due to 9-bit quantization of DC in Intra-mode.

(4) Quantizers in Intra-mode

Since low sequency components usually have high energy in Inta-mode, care should be taken not to cause degradation by clipping. The degradation is clearly seen as blocky for still pictures, while it is almost invisible for motion sequences. According to experiments, quantizers with stepsize equal to or greater than seven do not cause clipping. Clipping usually tends to occur in DC and the first sequency in both horizontal and vertical directions, particularly in Intra-mode.

3. Consideration from Hardware View Point

(1) Expansion of Flexibility

Flexibility is expected of the current Flexible Hardware in several points including Transformer, Threshold and Classification Circuit, Quantizer, and VLC CODEC. These are realized by changing PROMs.

Picture quality improvement can be expected by careful choice of quantizers since the quality is readily changed by using different quantizer characteristics. Flexible Hardware will be much more useful if it expands its possibility by incorporating 'flexible' quantizer selection capability in that quantizer characteristics can be selected corresponding to Y/C, Intra/Inter, Sequency e.t.c.

(2) Hardware Complexity

Figure 1 depicts a quantizer structure example corresponding to current Flexible Hardware. Input signals are 12-bit transform coefficients, 5-bit quantizer selection information, and a 1-bit block starting pulse (BLS), amounting to 18 bits. This BLS can be included in the 5-bit selection information by logical operation at the Selection Table.

Figure 2 shows a modified structure appropriate to adaptive quantization capable of changing characteristics corresponding to Y/C, Intra/Inter, and Low/Middle/High Sequency.

When this modification is implemented in Flexible Hardware, complexity increase is negligible i.e. a few commercial MSIs and two 12-bit(input) PROMs. Only by adding these ICs, great flexibility is obtained in quantizer function.

(3) Quantizer Selection Example

Flexible quantizer selection is carried out as exemplified in Table 1.

4. Conclusion

Picture quality improvement by appropriate quantizer selection is promising. In order to achieve this, it is recommended to implement the modified quantizer selection capability in the current Flexible Hardware. In the modified quantizer structure, the selection information represents a combination of quantizers.

MODE	Y/C	SEQUENCY			
		DC	Low	Middle	High
Intra	Y	Q0	Q1	Q2	Q2
	C	Q0	Q3	Q4	Q4
Inter	Y	Q5	Q5	Q6	Q6
	C	Q7	Q7	Q8	Q8

Table 1 Quantizer Selection Example

(Q0 is a 9-bit quantizer and fixed. A combination of quantizers from Q1 through Q8 change corresponding to allowed information rate /block, results given by picture analysis, transmission buffer state, etc. Maximum number of combination is 32 in Flexible Hardware when it is modified.)

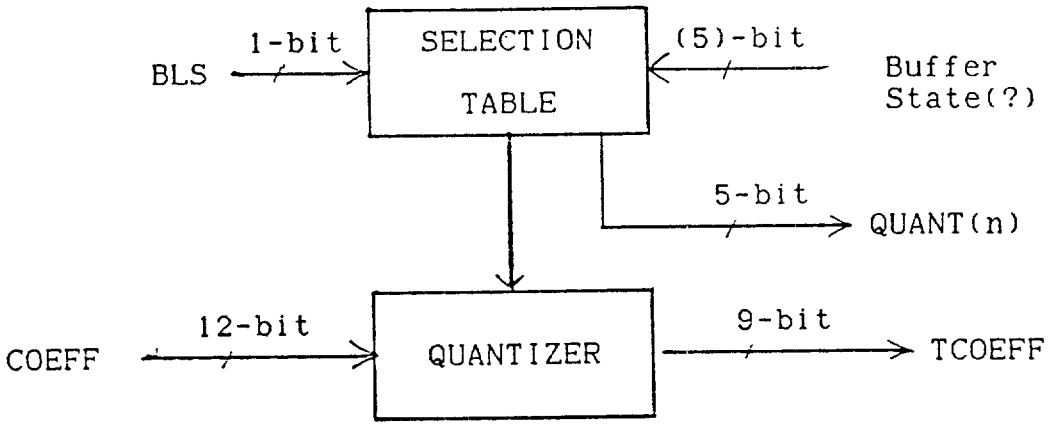

Fig. 1 Basic Quantizer Structure

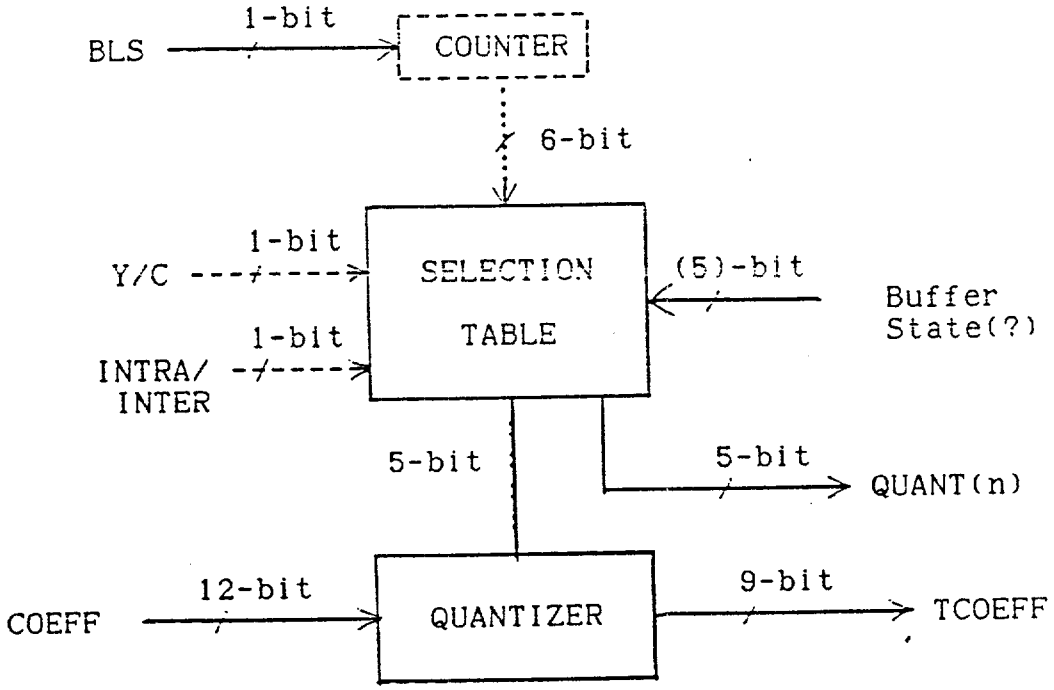

Fig. 2 Modified Quantizer Structure