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TITLE : SOME OBSERVATIONS ON CODING CONTROL

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1. Introduction

Coding control methods are not subject to standardization, and each country and organization should therefore be left sufficient leeway to make its own innovations. As it has such a great effect on picture quality, however, coding control cannot be considered as completely separate from coding algorithms , and for this reason, some kinds of unified discussion of coding control is necessary. In this document, we offer some comments on the problems involved in coding control elements, picture quality and buffer control systems.

2. Problems to be Considered

In general, it is impossible to specify what constitutes the most suitable all-round codec control system - for example, broadcast codecs using intrafield prediction and visualphone codecs using interframe coding naturally require different control systems.

The basic characteristic of the 384 kbit/s codec is that the frame rate is allowed to vary from 2 : 1 to 3 : 1. In first generation videoconferencing codecs, the frame rate was basically 1 : 1, and if it was not, an "emergency situation" was considered to have arisen. The present codec is however fundamentally different from this. In addition, we have to consider that a codec must be required to operate at n * 384 kbit/s, in which case it would be necessary to reproduce the 1 : 1 operating state.

Given the above conditions, we must therefore enquire as to what is the most suitable control system.

3. Problems of Control Based on Buffer Memory Occupancy

(1) Problems from the view point of hardware incrementation

In order to realize a variable frame rate of 1 : 1 - 3 : 1 under the fixed clock rate, the most suitable way of proceeding is to have a codec which can operate intermittently.

This may involve processing one entire picture and interrupting the operation until the next picture frame, as shown in Fig. 1(A), or processing from the top down as shown in Fig. 1(B).

Whichever method is adopted, i.e. Fig. 1(A) or 1(B), if it is desired to control quantization characteristics using buffer memory occupancy, it will be necessary to provide another buffer in addition to the buffer used for the actual transmission, and to perform dummy buffer control in parallel.

Control methods based on buffer memory occupancy are, in principle, suitable for coding system with no frame dropping. If an attempt is made, however, to employ buffer memory occupancy control in some way or other when frame dropping control is also used, the hardware may become rather complicated.

Further, as the transmitting and receiving clock system is independent, control data must be sent separately depending on the buffer memory occupancy, and this leads to an increase in the amount of transmission data.

(2)Problems as seen from a visual point of view

For low bit rate Codecs, good visual results will be obtained by controlling as large an element as possible, for example one frame, so that coding distortion is not concentrated in a specific area, and is the same anywhere in the frame. If on the other hand the amount of distortion is controlled by taking any small screen elements (block elements or group of block line elements) independently of the input signal, for example by means of the buffer memory occupancy, there will always be a deterioration of quality in some part of the picture, and visual characteristics will be poor too.

It has been shown that, to improve the total S/N ratio, an effective method is to maintain the distortion constant over a long period of time. The control should also be made smoother by ensuring the buffer is large enough.

If we use visual characteristics such as the ease with which distortion is perceived by the eye, moreover, it is also possible to control the amount of distortion depending on the classification of the input signal such that all blocks appear to have the same distortion. Methods of controlling the amount of generated data or distortion by means of tne motion vector are examples of this, and it is effective to control blocks based on some kind of classification. It must not however be forgotten that this is just a supplementary method of control, or a method of control intended to improve visual effects.

4. Conclusions

Our opinion regarding the above coding control systems may be summarized as follows:

1) In coding systems which assume variable frame rate control, parameter control based on buffer memory storage ocupancy is not suitable.
2) Distortion control should in principle be carried out in units of 1 frame.
3) Supplementary distortion control in each block can also be included, but this should be based on the results of classification.

Appendix

- Actual examples of control systems -

For the reasons we have described above, it is in principle effective therefore to perform parameter control in frame units. Two types of such control are possible, viz. the feedback system and the feed forward system.

(1) Feedback control system

In this system, the parameters are fixed during 1 frame, and coding proceeds progressively from the top down as shown in Fig. 1(B). The system displays the frame once the whole frame has been coded.

As a result, after N time sequences have been processed, the parameters are changed if the value of N is different from the predetermined frame dropping rate. Further, the number of bits used in coding the previous picture is calculated from the buffer storage occupancy when coding began (bs), and the occupancy when coding ended (be). Using this information, the parameters can then be changed.

In feedback control, the range of buffer fluctuation is equivalent to the transmission capacity in 1 time sequence (10 kbit) $+\alpha$, so the delay due to the buffer is in principle only 30 $+\beta$ msec. Also, since the smallest element subject to frame dropping control is 1 time sequence, discomfort due to an irregular situation (for example, inclusion of 1 : 1 or 3 : 1 in a frame dropping rate of 2 : 1) can be reduced. This means that lip sync. can be obtained more easily.

It is clear that this kind of system is suitable for coding control with low bit rates.

At the same time, even-when the parameter n in the expression n * 384kbit/s is 4 or 5, coding at a frame dropping rate of 1 : 1 is probably feasible using a control system based on the buffer storage occupancy (values of bs and be) as described above.

(2) Feed forward control system

In this system, the amount of data is estimated roughly beforehand, and fine control is performed using the buffer memory occupancy.

Depending on the classification results, the relation between the amount of input data to be coded and the parameters to be controlled is first assessed. Actual transmission rates can then be approximated fairly accurately, and coding is carried out in picture unit based on this system as shown in Fig. 1(A).

This estimation does not however necessarily guarantee that there will be perfect equivalence to the transmission rate. Fine control is carried out, therefore, by the buffer memory occupancy.

In feed forward control, it is generally impossible to perform the coding operation required to obtain the specified transmission rate on real time, so the delay is considerable.

Further, since the amount of generated data has been assessed, control is stable, and buffer overflow hardly ever occures.

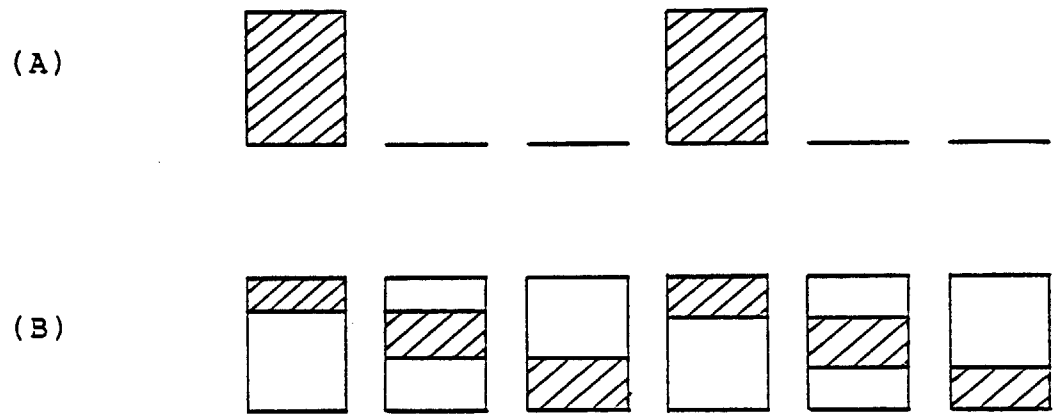

Figure 1. Intermittent operation of n * 384 kbit/s codec