CCITT SGXV
Working Party XV/1
Experts Group for ATM Video Coding

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SOURCE : Japan
TITLE : Some observations on variable bit rate coded video signals
PURPOSE : Information

1. Introduction

Variable bit rate video coding technique is expected to achieve constant picture quality. However, from the standpoint of effective network resource management a user must declare and keep peak and average bit rates even for variable bit rate services. The values of these bit rates depend on the usage parameter control (UPC) mechanism used in the network. We have made some observations on variable bit rate coded video signal assuming that the UPC mechanism is based on sliding (moving) window. (Fig. 1 Ref. AVC-13) We are concerned with the relation between bit rate and window size. Furthermore some considerations are given on picture quality of variable bit rate coding.

2. Bit rate and window size

The measurements have been made under the following conditions ;

*The quantizer is fixed to maintain constant picture quality.
*The sliding window mechanism is used for the usage parameter control.
*Peak and average bit rates are watched by the same sliding window mechanism but with different window sizes.

(1) Bit rate when window size is relatively small

(a)Test sequences ;
Scene 1 : News studio (containing scene changes)
Scene 2 : On the street (taken with a handy camera)
Scene 3 : Swimming fish (taken with a handy waterproof camera)
Every video scene is a broadcast program.

(b)Coding algorithm ; Extended H.261 (Fixed quantizer)
(c)Picture format ; 720x240 60fields ,4:1:1
(d)Sliding step ; 1 cell (2.8×10^{-3}msec)
(e)Actual average bit rate and S/N

Scene 1: g=2 : 15.8Mbit/s : 46.7dB
g=4 : 7.8Mbit/s : 43.3dB
g=6 : 5.1Mbit/s : 41.3dB
Scene 2: g=2 : 24.9Mbit/s : 46.9dB

g=4 : 12.7Mbit/s : 42.7dB

g=6 : 8.5Mbit/s : 40.6dB

Scene 3: g=2 : 33.1Mbit/s : 47.5dB

g=4 : 17.8Mbit/s : 43.1dB

g=6 : 12.1Mbit/s : 40.9dB

(f)Results ;

Figure 2 shows the relation between window size and maximum value of normalized bit rate through the whole sequence. Bit rate decreases rapidly. This fact suggests that the instantaneous peak bit rate can be reduced significantly by a small buffer, in other words without making a long delay.

(2) Bit rate when window size is relatively large

(a)Test scenes ;

Scene 4 : Flower garden

Scene 5 : Table tennis

Scene 6 : Football

Scene 7 : Salesman.

(b)Coding algorithm ; Extended H.261 (Fixed quantizer)

(c)Picture format ; CIF

(d)Sliding step ; 1 frame (33msec)

(e)Actual average bit rate and S/N

Scene 4: g=4 : 6.1Mbit/s : 43.26dB

Scene 5: g=4 : 10.6Mbit/s : 43.35dB

Scene 6: g=4 : 6.6Mbit/s : 43.44dB

Scene 7: g=4 : 4.5Mbit/s : 43.39dB

(f)Results ;

Figure 3 shows the fluctuation of measured bit rates with several window sizes. The larger the window size, the smaller the maximum value of bit rate. Figure 4 shows the relation between window size and maximum value of bit rate. Bit rate decreases for "Table tennis" and "Football". However for "Salesman" decrease of bit rate is not remarkable.

3. Some considerations on picture quality of VBR video coding

The following two assumptions are made ;

*The value 4 for g (quantization step size) does not cause any degradation of picture quality from a standpoint of human perception. In other words, it has no meaning to use smaller values than 4 for g.

*The network charge for VBR service is the same as that of CBR service if average bit rate is the same. This assumption corresponds to the case that

the network is sufficiently grown up. (Ref. AVC-47)

The following results are derived from these assumptions.

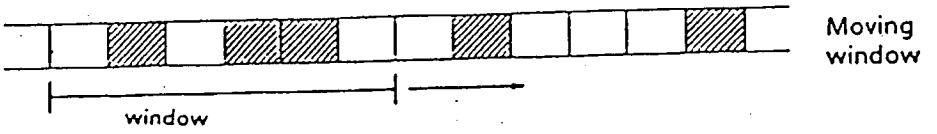
(a) Coding bit rate is smaller than the declared average bit rate.
(Period 'a' in Fig. 5)
→Picture quality is the same as that of CBR video coding.
In this case, CBR video coding may use smaller values than 4 for g to avoid buffer underflow. However it makes no difference for picture quality according to the first assumption.

(b) Coding bit rate is larger than the declared average bit rate.
(Period 'b' in Fig. 5)
→Picture quality is the same as that of CBR video coding.
In this case, not only CBR but also VBR video coding must control the value of g to maintain the information generation under the declared value. In this case, the picture quality obtained by VBR video coding is the same as that of CBR video coding.

(c) Coding bit rate is smaller than the declared average bit rate without a short burst.
(Period 'c' which consists of 'd''e''f' in Fig. 5)
→There is a possibility that picture quality of VBR coding is better than that of CBR video coding.
CBR video coding may use smaller values than 4 for g to avoid buffer underflow at period 'd'. However, while period 'e', CBR video coding should use a larger value than 4 for g. On the other hand, VBR video coding may maintain the value 4 both at period 'd' and 'e'. Therefore, there is a possibility that picture quality at period 'e' can be better than that of CBR video coding. This possibility depends on the window size and the time length of period 'e'.

4. Conclusion

Bit rate observation on VBR coded video signals is given where a sliding window mechanism is used with several window sizes. Some considerations on the picture quality of VBR video coding have been presented.



- Moving window
  Moving window allow X arriving cells in an arbitrary time interval containing Y time slots. In order to control this, it is necessary to collect information about arrival time for all the cells arriving in the last Y time slots.

Fig. 1 Usage Parameter Control based on sliding (moving) window (Ref. AVC-13)

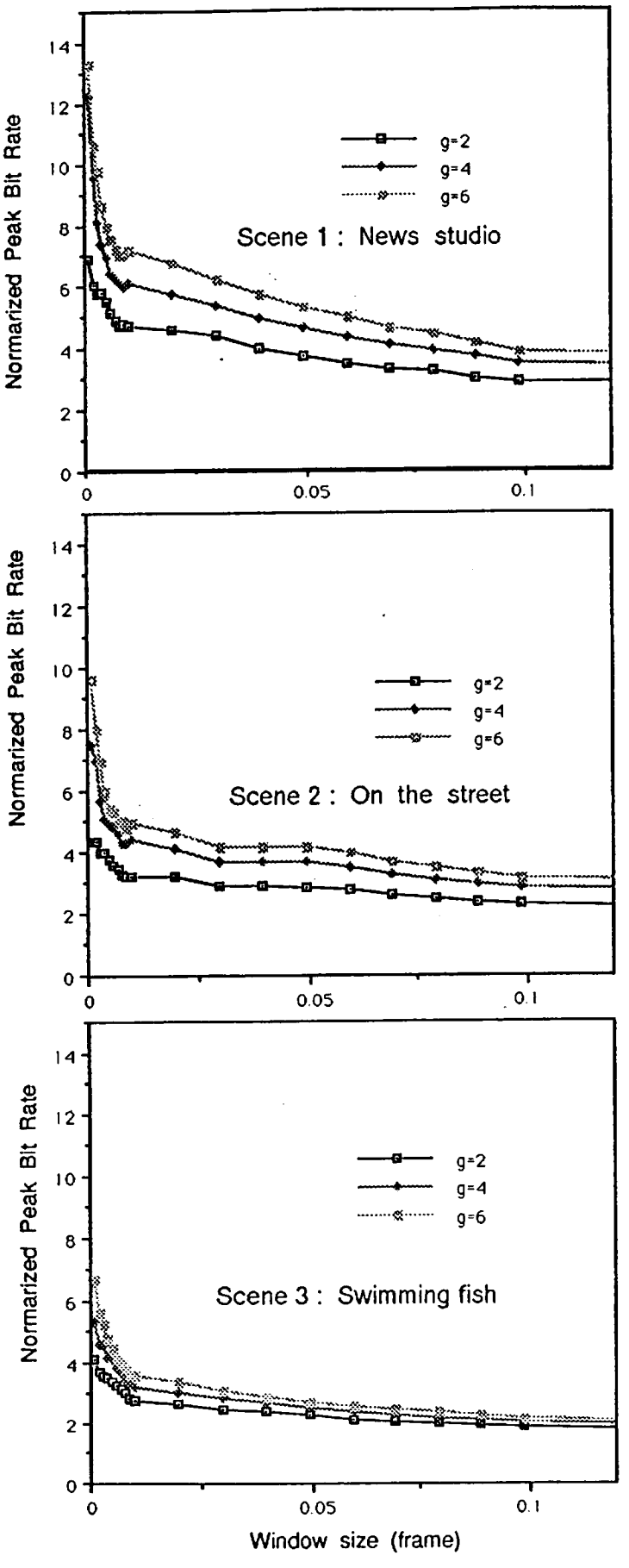


Fig. 2 Bit rate vs. window size (small)

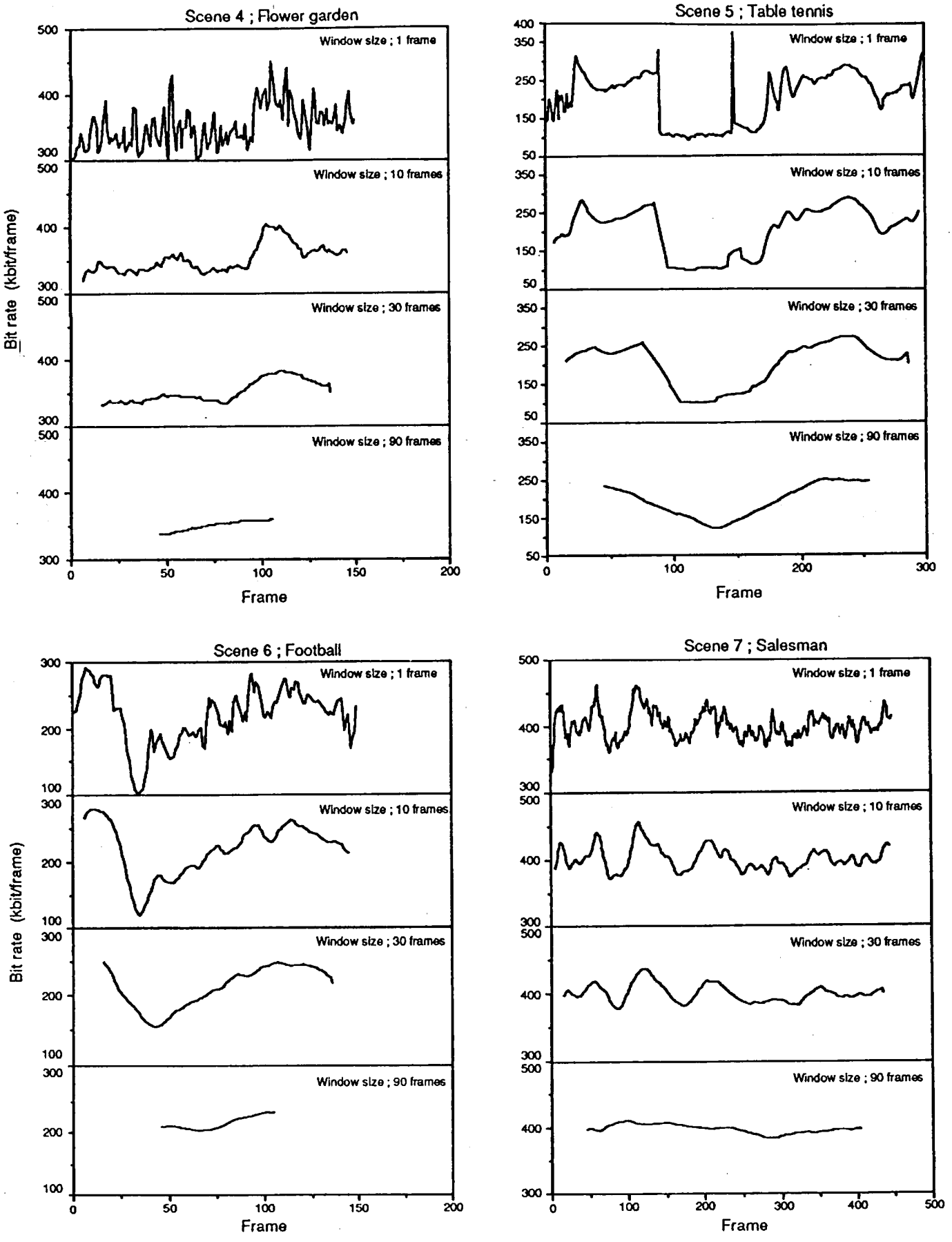


Fig. 3 Fluctuation of measured bit rates with several window sizes

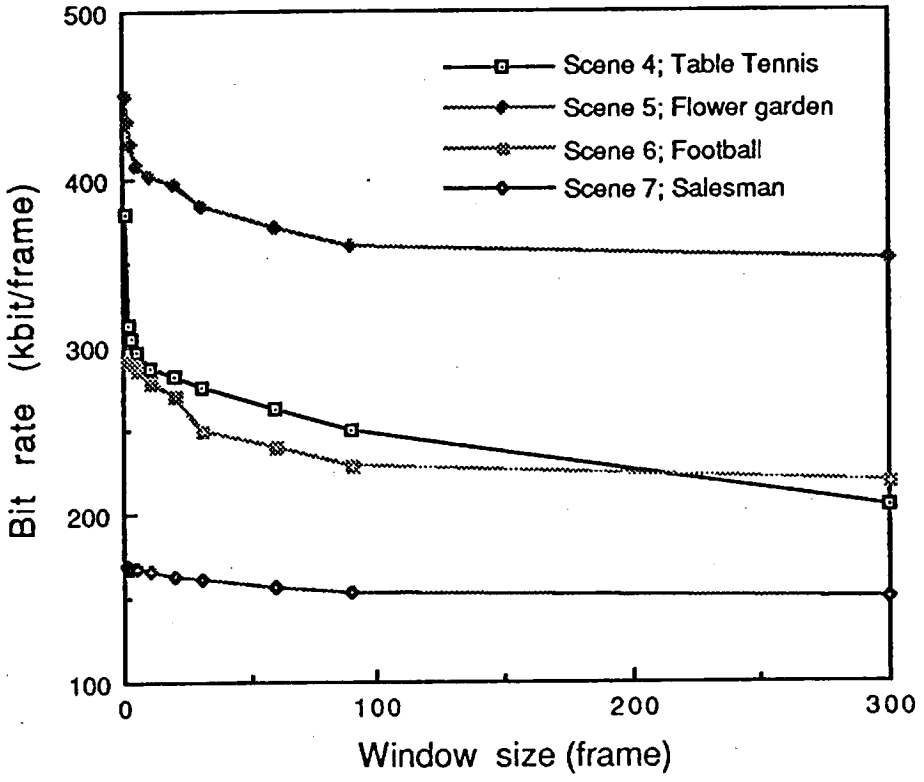


Fig. 4 Bit rate vs. window size (large)

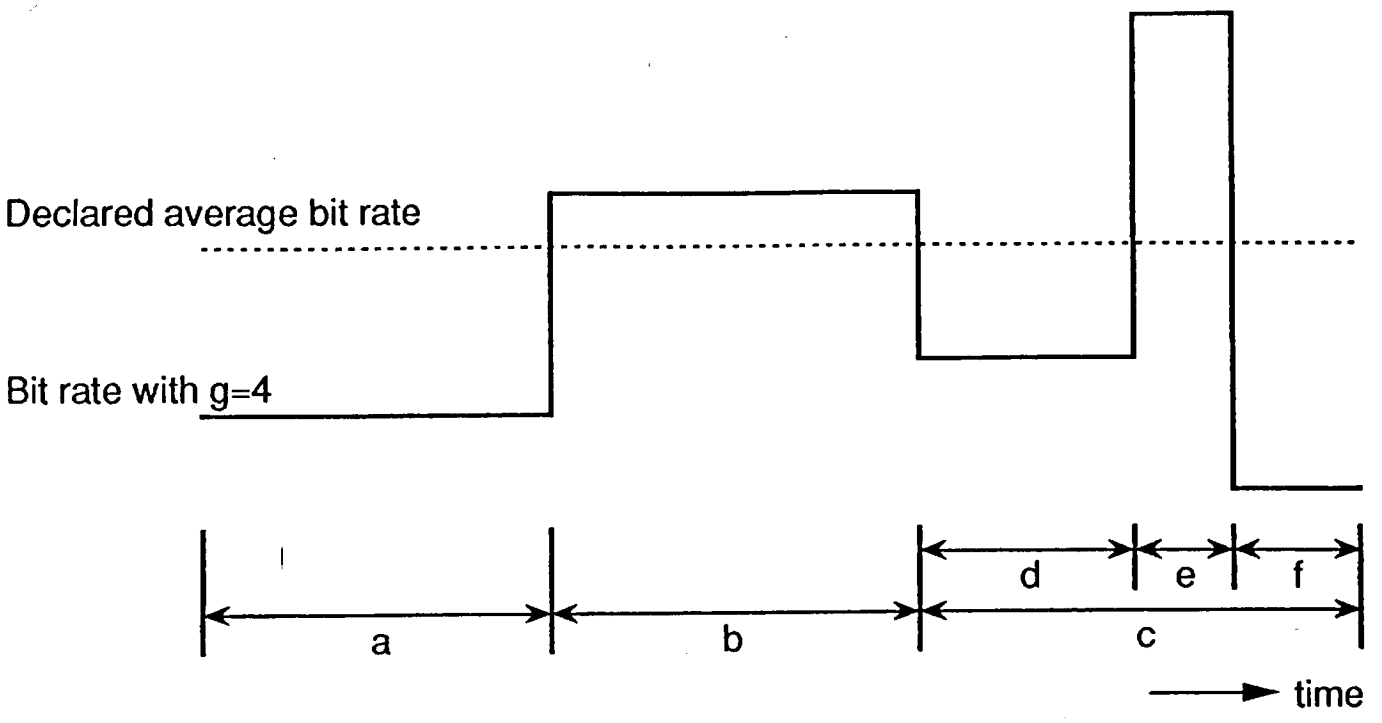


Fig.5 Declared average bit rate vs. bit rate with constant g