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TITLE: Variable slice sizes Vs small fixed slice sizes
PURPOSE: Information

1 Introduction

This contribution summarises some experiments performed to compare the cell loss resilience of small variable sized slices, to that of small fixed sized slices. This work follows that described in MPEG 93/019 (AVC-428) [1], except that the described field in the cell payload which points to the start of a slice in not used. The variable sized slices are simply obtained by keeping track of how full the current cell is, and at the end of the first macroblock in every cell (or every second cell, third, ...) a new slice is started.

By attempting to match the size of a slice with an integral number of cells, the number of macroblocks discarded while resynchronising (i.e. macroblocks which appear after the cell loss but before the next start code) can be minimised. In addition, this approach also ensures that there is only one resynchronisation point in a cell.

When using fixed size slices, it is possible for a number of macroblocks to be contained in a cell before a slice start code. These macroblocks will be discarded if the previous cell was lost, even though the decoder will resynchronise in this cell. In addition, as the size of a macroblock can vary greatly between the different coding modes, the situation can arise where several slice start codes appear in the same cell, which is a waste of bandwidth.

2 The effect of varying the number of cells per slice

In this section the effect of trying to adjust slice sizes to match a number of cells is investigated, with the results presented in Table 1. When coding at 4 Mbits/second, N = 12, M = 3, the minimum, maximum and average number of macroblocks per slice for each type of frame and for the entire sequence are shown, for the short portions used of the sequences *Flower garden* and *Mobile & Calendar*. The quality of the encoded sequences, taking into account the varying amounts of overhead information introduced by the slice headers is also shown.

Sequence	CPS	SNR	Intra frames min	max	mean	Predicted frames min	max	mean	Bi-pred frames min	max	mean	Entire sequence min	max	mean
flowers	1	28.91	1	10	1.14	1	27	2.65	1	39	8.06	1	39	3.64
	2	29.19	1	15	2.20	1	37	5.26	2	41	15.59	1	41	7.08
	3	29.28	1	16	3.37	1	38	7.87	1	46	22.89	1	46	10.64
	4	29.32	1	18	4.55	1	40	10.52	4	79	29.99	1	79	14.18
	6	29.36	2	24	6.91	2	44	15.81	7	87	44.23	2	87	21.27
	8	29.38	2	26	9.25	2	68	21.07	1	108	58.13	1	108	28.27
	10	29.39	5	31	11.62	6	78	26.33	13	131	72.00	5	131	35.29
calendar	1	28.85	1	5	1.07	1	37	2.68	1	90	8.59	1	90	3.63
	2	29.07	1	8	2.06	1	47	5.29	1	133	16.53	1	133	7.03
	3	29.14	1	11	3.17	1	84	7.95	3	158	24.07	1	158	10.56
	4	29.17	1	14	4.27	1	92	10.58	4	183	31.64	1	183	14.09
	6	29.21	1	18	6.47	1	134	15.87	8	226	46.67	1	226	21.11
	8	29.23	1	24	8.69	4	147	21.12	10	263	61.37	1	263	28.09
	10	29.24	3	30	10.92	8	170	26.40	17	251	75.88	3	251	35.08

Table 1: The minimum, maximum and average number of macroblocks per slice for each type of frame, and for the entire sequence, along with the encoded quality, obtained when matching the slice size to a number of cells.

As the number of cells between slice start codes increases (also referred to as the number of cells per slice), the length of a slice increases, as does the average number of macroblocks per slice. Even though the size of slices changes by a factor of 10, the change in quality between the smallest and largest slice sizes is only around 0.4 dB.

The number of macroblocks contained in a predicted frame slice is approximately 2.5 times the number of macroblocks contained in an intra frame slice, and the number of macroblocks contained in a bi-direction frame slice is about 3 times that contained in a predicted frame slice. This difference is due to the varying number of bits produced by coding the different types of macroblocks.

A consequence of this variation in the number of macroblocks contained in a slice is that the area of the screen affected by a cell loss will also vary with the different types of frames. To correct this imbalance, a different number of target cells can be used for each type of frame. For example, intra frames should try to fit slices into 10 cells, predicted frames fit slices into 4 cells, and bi-directional frames fit slices into 2 cells, giving approximately the same number of macroblocks per slice.

3 Cell Loss Performance

Table 2 summarises the parameters under which the comparison between fixed and variable sized slices is performed. In both cases, the decoder conceals lost macroblocks using motion compensated prediction to improve the prediction from the previous frame.

Each 50 frame sequence is decoded 5 times, each time with a different random number seed, increasing the effective decoded sequence length to 250 frames. The SNR values used to present the results are averaged over the 5 random number seeds.

An error free period is provided for the first frame, and ensures that no cell losses occur while a reference picture is being established, as cell losses affecting this frame have a much greater effect than losses from other intra frames.

Parameter	**Value**
Sequences	Flower garden
	601 format, 50 frames
Coder	Frame based TM2, N = 12, M = 1
Bit rate	4 Mbits/second
Cells per slice	2
Macroblock per slice	6
Cell loss ratios	0.C01 (01
Error concealment:	Motion vector interpolation from the previous frame.
Random number seeds used	5
Error free period	First frame (approx. 1000 cells)

Table 2: The conditions under which the cell loss resilience comparison between fixed and variable slices are performed.

Table 3 presents the results of this comparison. The SNR results show that there is a small improvement in quality when using the variable slice size approach.

Fixed size slices		**Variable size slices**	
Macroblocks per slice:	3	Cells per slice:	2
		Average macroblocks per slice:	7.2
Sequence quality:		Sequence quality:	
- without loss	28.28	- without loss	28.36
- CLR = 0.001	27.33	- CLR = 0.001	28.19
- CLR = 0.01	24.77	- CLR = 0.01	25.23

Table 3: A short comparison between the error resilience of fixed and variable sized slices, for the *Flower Garden* sequence.

4 Summary

This contribution has considered the effect of trying to match the length of a slice to a multiple of the cell payload length, by varying the number of macroblocks within a slice. In addition, an attempt is made to start a slice as soon as possible after the start of a cell. A number of different multiples of the cell payload length are investigated, to determine the change in overall sequence quality and average number of cells in a slice. The error resilience of this approach is compared with that of a fixed number of macroblocks per slice. Further work is required to investigate the effect of cell loss on a wider range of slice sizes.

References

[1] Australian UVC consortium contribution to CCITT SGXV Experts group for ATM video coding. *A hybrid AAL packing scheme*, January 1993. Document AVC-428.