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1. Introduction

Two layered compatible coding and simulcast are two ways to achieve compatibility between MPEG-1 and MPEG-2. Simulcast achieves compatibility by the generation of two bitstreams, one that satisfies the MPEG-1 standard and one that satisfies the MPEG-2 standard; a decoder selects and decodes one of these bitstreams. Two layered coding achieves compatibility by the generation of two bitstreams, one that satisfies the MPEG-1 standard and another that can be used with the first to obtain improved picture quality; a simple decoder needs only to decode the MPEG-1 bitstream, while an enhanced decoder must decode both bitstreams.

This contribution describes an experiment done to compare the performance of these two schemes when they are subject to cell loss.

2. Software description

This section describes the simulation software used for these experiments.

2.1. Base layer of two-layered scheme

The source CCIR 601 resolution source pictures were down-sampled to SIF by the process described in the MPEG Test Model [1]. These pictures were coded using the MPEG-1 coding algorithm, at a bit rate of 1.5Mbit/s, using adaptive rate control. These coded SIF pictures were then up-sampled to CCIR 601 resolution by the process described in the test model.

2.2. Second layer of two-layered scheme and simulcast scheme

The source CCIR 601 resolution pictures were coded using the MPEG Test Model with the frame-field adaptive prediction and also compatible prediction in the case of two-layered coding.

For the compatible prediction, decisions were made for 16*8 blocks as described in appendix G.1 of the Test Model, that is, the decision was made independently for each of the fields that make up a macroblock. There is a two bit code at the end of the macroblock type to indicate whether field 1 or field 2 or both or neither have been coded compatibly . Adaptive rate control was used.

2.3. Packetization and cell loss process

For the two-layered scheme the bitstreams produced by the two layers were packetized independently.

The packetization and cell loss process used was that defined in [2]. The pseudo-random number generating shift registers were initialised by shifting 10000 times rather than the stated 1000 times. It was found that when only 1000 shifts were performed, the resulting sequence of random numbers had a low mean value, probably due to the large number of zeros still in the shift register; the resulting low random numbers would have caused the actual cell loss rate to be higher than the desired cell loss rate.

For the base layer of the two-layered scheme, all cells were set to have high priority.

For the simulcast scheme and the second layer of the two-layered scheme, all picture, group and sequence headers, as well as all intra picture data, were set to have high priority, while all other data were set to low priority. Cells were stuffed with zero bytes where necessary to allow sequence, group and picture headers to be aligned to the start of cells.

Independent random number generating shift registers [2], were used for high and low priority cells within a single bitstream. The cell sequence numbers were however continuous, that is, if a high priority cell followed a low priority one, its sequence number would be one more than that of the preceding low priority cell. Consequently, when a cell is lost, its priority can not be determined.

2.4. Decoder cell loss recovery mechanism

Cell loss was detected by a break in the cell sequence numbers. As only four bits are used for this, cell loss will not be detected when a burst of a multiple of 16 consecutive cells are lost.

When cell loss is detected, the decoder tries to resynchronize to a slice, picture or group start code. All macroblocks between the last to be fully decoded before cell loss and the first to be decoded after resynchronization are reconstructed assuming them to be of the default macroblock type.

For the simulcast scheme, the default macroblock type is forward prediction, zero vector and no coefficients. For the two-layered scheme, the default macroblock type is full compatible prediction and no coefficients.

3. Experiment

A total bit rate of 4Mbit/s was used to code CCIR 601 resolution pictures of the Mobile and Calendar sequence.

In the first run, referred to as simulcast, the CCIR 601 resolution source pictures were coded with 2.5Mbits/s with no compatible prediction. In this case it is assumed that another 1.5Mbits/s have been used to code SIF resolution pictures.

In the second run, a two-layered compatible coding scheme was used. The base layer coded SIF resolution pictures using the MPEG-1 coding scheme at a bit rate of 1.5Mbits/s. The second layer coded the CCIR 601 resolution pictures with the remaining bit rate of 2.5Mbits/s, selecting the compatible prediction whenever it was best to do so.

The resulting bitstreams were packetized and subjected to cell loss. No cell loss was performed on the high priority cells. Low priority cells were subject to a cell loss ratio of $1.0*10^{-3}$ and a mean burst of cells lost of 4.0 [2].

The resulting packetized bitstreams were decoded and compared. Also, to compare the performance of the two cell loss recovery mechanisms, the second layer bitstream of the two-layered scheme was decoded using the simulcast cell loss recovery mechanism.

4. Results

Due to the pseudo-random nature of the cell loss mechanism, the actual cell loss statistics were not exactly as stated above. The low priority cell loss statistics are shown in tables 1 to 4.

For both simulcast and two-layered coding, the cell loss rates and the burst lengths are slightly higher than $1.0*10^{-3}$ and 4.0. More cells are listed for two-layered coding than simulcast because more bits are used for predicted and interpolated pictures in this case, as bits are saved in the intra pictures. Consequently, more cells are lost for the two-layered scheme compared to simulcast. Tables 3 and 4 show which pictures were affected by cell loss. Note that the patterns are exactly the same: for simulcast, the 10 lost in picture 75 and the 3 lost in picture 73 are part of a low priority burst of cells lost of length 13, interrupted by a high priority cell containing a picture header.

Picture type	ALL	Intra	Predicted	Interpolated
Total number of cells	20968	0	11279	9689
Total cells lost	34	0	15	19
Mean cell loss ratio	$1.62*10^{-3}$	0	$1.33*10^{-3}$	$1.96*10^{-3}$
Number of bursts	6	0	2	4
Mean burst length	5.667	0.000	7.500	4.750

Table 1. Cell loss statistics for simulcast.

Picture type	ALL	Intra	Predicted	Interpolated
Total number of cells	23152	0	12242	10910
Total cells lost	41	0	13	28
Mean cell loss ratio	$1.77*10^{-3}$	0	$1.06*10^{-3}$	$2.57*10^{-3}$
Number of bursts	6	0	1	5
Mean burst length	6.833	0.000	13.000	5.600

Table 2. Cell loss statistics for two-layered coding.

Picture no.	No. cells lost
23	3
75	10
73	3
85	9
93	5
107	4

Table 3. Cell lost occurrence for simulcast.

Picture no.	No. cells lost
20	3
69	13
77	9
82	5
97	4
103	7

Table 4. Cell loss occurrence for two-layered coding.

The simulcast scheme was compared to the two-layered scheme when both were implementing the same cell loss recovery mechanism. In this case the subjective picture quality of the two layered scheme was worse than the simulcast scheme. This is due to two factors, firstly more cell loss occurred in the two-layered scheme, and secondly, it seems to have affected the more critical parts of the picture.

The simulcast scheme was compared to the two-layered scheme implementing base layer cell loss recovery. In this case the subjective picture quality of the two-layered scheme was significantly better than that of the simulcast scheme.

The picture quality of the simulcast scheme was not acceptable. The picture quality of the two-layered scheme was acceptable for teleconferencing applications.

5. Conclusions

An preliminary investigation of the cell loss resilience of simulcast and two layered coding has been performed.

It was shown that cell loss recovery using base layer data is more effective than cell loss recovery using previous picture data. Consequently, two-layered coding was shown to be more resilient to cell loss than simulcast.

Further work needs to be done to improve the cell loss recovery mechanism for both simulcast and two-layered coding.

6. References

[1] ISO-IEC/JTC1/SC29/WG11 MPEG 92/N0245, MPEG Test Model 2.
[2] CCITT SGXV, WP XV/1, AVC-205, Cell loss experiment specifications.