CCITT SGXV
Working Party XV/1
Specialist Group on Coding
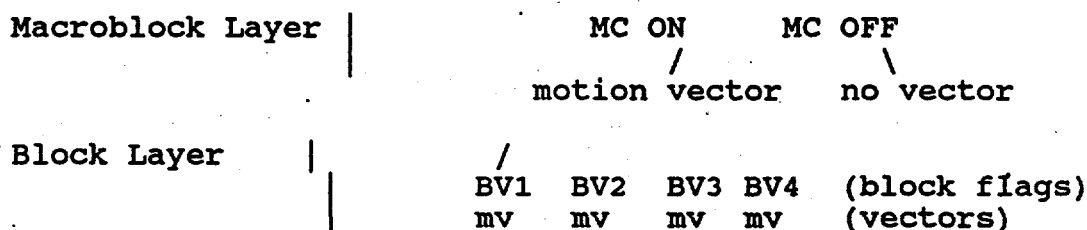for Visual Telephony

Doc   # 453
Oslo
March 89

Title: Motion Vectors for 8*8 Blocks in RM7.
Source: France, FRG, Greece, Italy, Netherlands, Norway, Sweden, UK

Introduction

The current specification for Reference Model 7 (RM7) only has provision for the
motion compensation of full macro blocks. Recent work [1] has shown that for RM6
running at 64kbit/s processing the standard CCITT test sequences of Miss America,
Claire and Trevor at full Common Intermediate Format (CIF) resolution there is little
to be gained by individually motion compensating the 8*8 pixel sub-blocks of a
macro block. While this previous work used RM6 the models RM7 and RM6 are
sufficiently close in specification such that conclusions drawn for motion
compensation in RM6 are valid for RM7. Because the work in [1] only describes the
results for a small set of possible operating conditions it would be dangerous to draw
too·strong a conclusion. The work described below extends the scope of test material,
spatial resolution and bit rates in an attempt to draw a more representative
conclusion. The quarter CIF results were prepared using sequences generated in a
manner described in [2].

Generating and Using Sub-Macroblock Motion Vectors.

The existing hardware video multiplex specification expects a macroblock motion
vector in the macroblock information layer and also has the potential to include
additional motion information in the block information layer. The information in the
block layer could describe the motion of an 8*8 pixel block relative to the associated
16*16 pixel macroblock. By introducing some additional flags it becomes possible to
perform motion compensation on a macroblock level or block level without
significantly affecting the current performance. The following describes such a
scenario.

```
Macroblock Layer  |              MC ON       MC OFF
                  |               /            \
                  |          motion vector    no vector


Block Layer       |       /
                  |      BV1  BV2  BV3 BV4   (block flags)
                  |      mv   mv   mv  mv    (vectors)
```

Only if the associated TYPE 3 information indicates a motion compensated macro
block will there be a possiblity of block level motion vectors. The block level vectors
can be considered as an option, with TYPE 1 or TYPE 2 information indicating their
use. Assuming that block level vectors were flagged as being used, block flags (BV1,
BV2, BV3, BV4) would indicate if the 8*8 blocks were motion compensated or not.
·If a block was flagged as compensated then the associated motion vector would be
coded differentially with respect to the macro motion vector.

A scheme as described here was implemented for RM7 and on a modified version of
RM7. It was noted that the quantiser step size control in RM7 was inadequate, such
that the associated loop instabilty influenced the assessment of other coding

parameters. The modification was performed by damping the rate of change of the quantiser step size. Specifically a dummy buffer size was calculated:

dummy_buffer(n) = dummy_buffer(n-1) + (buffer - dummy_buffer(n-1))/16

where n = current GOB
       n-1 = previous GOB
       buffer = actual buffer content
       dummy_buffer = dummy buffer content

The value 'dummy_buffer' was then used to calculate the quantiser step size as normal. A large improvement in performance was obtained with this buffer control strategy.

Results

Note full block signalling was used at all times for RM7+8*8MC with no TYPE 1/2 flag being used to indicate the presence of sub-macroblock motion compensation.

RM7 = Normal Reference Model 7
RM7 + 8*8MC = RM7 with motion compensation performed as described above.
RM7 + BC = RM7 with modified buffer control.
RM7 + BC + 8*8MC = RM7 with modified buffer control and with motion compensation performed as described above.

		s/n ratio (Y) RM7	s/n ration (Y) RM7 + 8*8MC
	Missa	37.57	36.52
	Claire	37.75	37.29
Full CIF	Blue Jacket	33.21	33.41
	Salesman	31.65	31.33
	Swing	35.23	33.99
	Missa	38.00	37.76
	Claire	37.41	37.72
1/4 CIF	Blue Jacket	36.27	36.49
	Salesman	34.70	34.86
	Swing	38.95	38.98

		s/n ratio (Y) RM7+BC	s/n ration (Y) RM7 + BC + 8*8MC
	Missa	37.79	36.79
	Claire	37.90	38.07
Full CIF	Blue Jacket	34.81	35.23
	Salesman	32.16	32.28
	Swing	35.73	35.44

	Missa	38.81	38.81
	Claire .	38.58	38.88
1/4 CIF	Blue Jacket	36.29	36.60
	Salesman	34.66	34.92
	Swing	38.50	38.47

NOTE: Remanining results will be provided when available.

Conclusions

The results for RM7 with the improved buffer control show an improved performance compared to RM7 (+1.6dB for Blue Jacket); more significantly the affect of applying 8*8 block based motion compensation to the modified model is also generally improved. The application of 8*8 block based motion compensation yields noticeable subjective improvements.

It is anticipated that further improvements can be obtained by optimally choosing whether to compensate at a macroblock or 8*8 block level.

Proposal

Suitable modification should be made to the video-multiplex structure to allow the facility of performing and using 8*8 blcok based motion compensation. The motion signalling data should be hierachical in nature, allowing encoders which can not generate 8*8 motion vectors the ability to efficiently signal only 16*16 motion vectors.

References

[1]   Best Matching in Motion Compensation. COST 211 Document Sim/88/81
[2].   Proposal for down filtering and up filtering at QCIF. UK/BTRL COST 211 bis Simulation Subgroup. Munich Jan 89.