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Title: MOTION COMPENSATION CONCLUSIONS

The following proposals/conclusions is the result of extensive work in several European laboratories.

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1. Fractional displacement.

Fractional displacement should not be included in the p·64 kbit/s standard.

2. Transmission of MV data.

The RM6 method (VLC of differential MV) should be used in the p·64 kbit/s standard.

3. MV range in hardware decoder.

± 15 pels in horisontal direction.
± 15 lines in vertical direction.

4. Motion vectors for each 8·8 sub-block.

A small gain is observed for p=1 in RM6. Further study is needed for higher bit rates as well as for ¼CIF.

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1. Fractional displacement.

A significant amount of simulation work has been undertaken in Europe in an attempt to establish if fractional motion vectors merit inclusion in the p·64 kbit/s standard. Early work suggested that fractional motion compensation does give some gain (a 2 dB gain in SNR). Later work has shown that similar gains can be achieved by including a simple 1-2-1 filter on all blocks with a non-zero motion vector. Fractional motion vectors are far more complex to implement in real time hardware than simple 1-2-1 filters.
We conclude that fractional vectors should not be included in the p·64 kbit/s standard.

2. Transmission of MV data.

In order to decide on the best scheme to transmit motion vector data five methods were compared. In the comparison a reduced version of RM6 was used, where the intra switch was not included. Average number of bits per picture are given in Table 1.

1. 8 bits per MV	(RM5)
2. 1D VLC of absolute MV.	(optimised for each sequence)
3. 2D VLC of absolute MV.	(optimised for each sequence)
4. 1D VLC of differential MV	(RM6)
5. 1D VLC of differential MV	(optimised for each sequence)

	MISS A	CLAIRE	SALESMAN	SWING
RM5	577	302	292	80
1D abs (opt)	492	238	234	74
2D abs (opt)	461	223	224	69
RM6	429	215	243	95
1D dif (opt)	418	206	231	76

Table 1. No of bits per picture for MV transmission.

Conclusions.

RM5 method is worst.
VLC of absolute MV is potential, 2D gives negligible gain.
VLC of differential MV works well, even with 3-step search.
Little potential to optimise the VLC in RM6.
If a motion estimation scheme is used which is matched to the RM6 method even better performance can be expected.
Therefore we propose that the RM6 method is included in the p·64 kbit/s standard.

3. MV range in hardware decoder.

Simulation work has indicated that there is no need to use any larger MV range than ±7. On the other hand, hardware experiance has shown large gains by going to ±15, especially for cases of violent motion. The main hardware overhead for this is in the encoder, where motion compensation is optional.
The hardware overhead in the decoder is negligible.
One can argue that bit consumption increases when a large set of motion vectors is possible. This would be a disadvantage for coders where only a small search area is used. This argument is however not true if VLC for differential motion vectors is applied.
The conclusion is that there is no need to restrict the standard to a small possible vector range. ±15 pels in both horisontal and vertical direction is considered as sufficient.

APPENDIX *to doc 416*

1. Motion vectors for each subblock.,

This appendix deals with the possibility of sending MCV information for each subblock. In RM6 the MCV is obtained only for each MB. This is mainly because the amount of overhead bits has to be kept below a certain limit for 64 kb/s coding. On the other hand the prediction may be improved by MCV for each subblock.

We have used a bitsaving method to give information of the subblock MCVs as an addition to the MCV for each MB. We have made simulations with and without this extra information and found a slight gain using subblock MCV for 60 kb/s coding. It is expected that the gain will be higher on higher bitrates (p=2 ->) because of a better prediction.

Furthermore it is expexted that this feature will be of considerable value for 1/4 CIF coding.

1.1 Description of the method.

- A MCV for the macro block is obtained as in RM6. We call this vector MCVO.

- The second step is to find separate vectors for each of the four 8*8 subblocks. A window of +/- 2 around MCVO is used. The vectors are biased to MCVO in the same way the vector for the MB is biased to the zero vector. The window used is shown in Figure 1a.

- Coding of the additional information:
Additional bits are needed to signal additional information on motion vectors for each subblock:

    -One bit is used to tell whether all subblock MCVs are equal to MCVO or not.
    -If the outcome is "not", the additional information is coded with a VLC where the numbers of bits are shown in Figure 1b.

The MCVs for each subblock are also used for chrominance prediction of 4*4 blocks.

2. Conclusion.

MCV for each subblock gives both objective and subjective gain for the sequencis CLAIRE and MISS AMERICA which was tested. The results will be shown on video tape.

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-2,2				2,2
		MCVO		
-2,-2				2,-2

a

6	6	6	6	6
6	5	5	5	6
6	5	1	5	6
6	5	5	5	6
6	6	6	6	6

b

Figure 1. a) the window used for subblock MCV information.
b) the number of bits used for coding ov the different motion vectors.