MOTION COMPENSATION TECHNIQUE FOR 2:1 SCALED-DOWN MOVING PICTURES

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1 INTRODUCTION This paper introduces new motion compensation (MC) techniques for 1/2 down scaled moving pictures through a frequency domain scaling decoder [1][2]. In the decoder, 4x4 Inverse Discrete Cosine Transform (IDCT) is applied to low frequency quarter of coded 8x8 DCT coefficients, and motion vectors (MV) are scaled by 1/2. Although aliasing error is not visible [3], and scaled down MV retains the full precision available at full size pictures [4], the down scaled pictures are still blurred. This problem, called "drift", is to be discussed here.

2 THE "DRIFT" PROBLEM In the scaling decoder, decoded image is different from locally decoded image in the encoder (see figure 1). Therefore prediction error is accumulated in B- and P-pictures. One reason of the problem is the "aliasing" error caused by down scaling [3] but we have pointed out that the drift is mainly caused by mismatching of MC filter's frequency characteristics between the encoder and the decoder [5].

3 MC FILTERS The MC filter produces a predicted image by motion compensating a previous image with MV.

3.1 MC FILTERS IN THE ENCODER In MPEG2, MC is performed in half-pel precision [4] as follows,

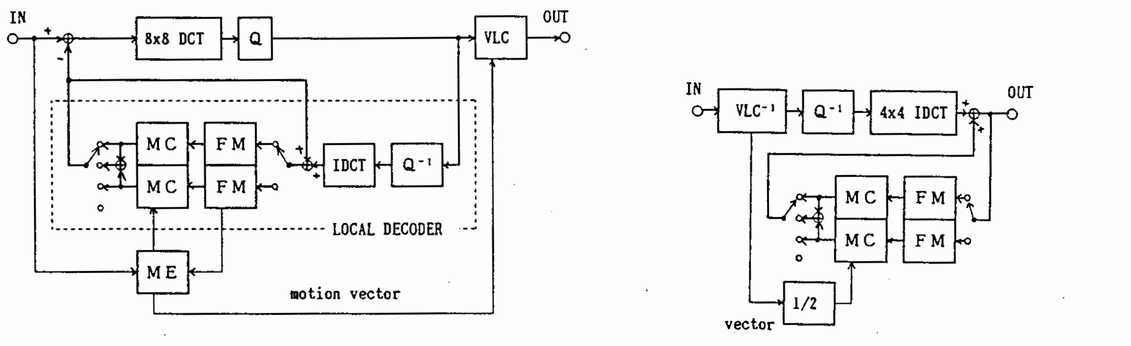
$$\begin{bmatrix} R(i) \\ R(i+1/2) \end{bmatrix} = 1/2 \begin{bmatrix} 2 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} P(i) \\ P(i+1) \end{bmatrix}$$

,where "R" and "P" indicate predicted pxl and previous pxl respectively.

3.2 MC FILTERS IN THE DECODER Dividing the MV by 2, the scaling decoder employs quarter-pel MC as follows.

"H2Q2" (half-pel: 2 tap, quarter-pel: 2 tap)

$$\begin{bmatrix} R(i) \\ R(i+1/4) \\ R(i+2/4) \\ R(i+3/4) \end{bmatrix} = 1/4 \begin{bmatrix} 0 & 4 & 0 & 0 \\ 0 & 3 & 1 & 0 \\ 0 & 2 & 2 & 0 \\ 0 & 1 & 3 & 0 \end{bmatrix} \begin{bmatrix} P(i-1) \\ P(i) \\ P(i+1) \\ P(i+2) \end{bmatrix}$$



a) Block diagram of the encoder *b) Block diagram of the scaling decoder*

Fig.1 Accumulation of error is perfectly canceled in the encoder (a), but not in the scaling decoder (b).

3.3 PROPOSED MC FILTERS IN THE DECODER The existing MC filter essentially effects a spatial low-pass filter [5]. Therefore the drift can be reduced by improving frequency characteristics of the MC filter as follows.

"H4Q2" (half-pel: 4 tap, quarter-pel: 2 tap)

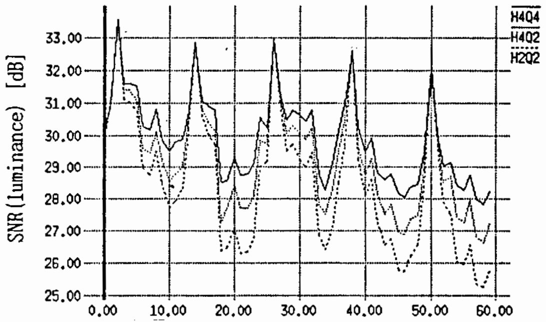
$$\begin{bmatrix} R(i) \\ R(i+1/4) \\ R(i+2/4) \\ R(i+3/4) \end{bmatrix} = 1/8 \begin{bmatrix} 0 & 8 & 0 & 0 \\ 0 & 6 & 2 & 0 \\ -1 & 5 & 5 & -1 \\ 0 & 2 & 6 & 0 \end{bmatrix} \begin{bmatrix} P(i-1) \\ P(i) \\ P(i+1) \\ P(i+2) \end{bmatrix}$$

"H4Q4" (half-pel: 4 tap, quarter-pel: 4 tap)

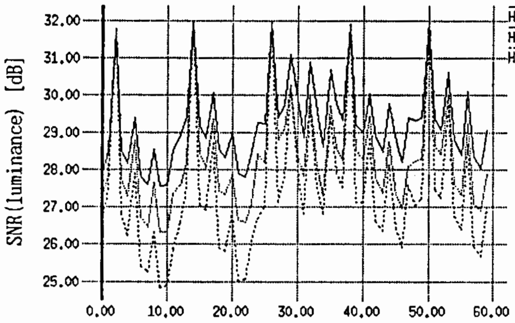
$$\begin{bmatrix} R(i) \\ R(i+1/4) \\ R(i+2/4) \\ R(i+3/4) \end{bmatrix} = 1/128 \begin{bmatrix} 0 & 128 & 0 & 0 \\ -7 & 105 & 35 & -5 \\ -16 & 80 & 80 & -16 \\ -5 & 35 & 105 & -7 \end{bmatrix} \begin{bmatrix} P(i-1) \\ P(i) \\ P(i+1) \\ P(i+2) \end{bmatrix}$$

These coefficients are driven from Lagrange's interpolation.

4 RESULTS Figure 2 compares our methods (H4Q4 and H4Q2) to the existing method (H2Q2) and indicates H4Q4 significantly reduces the drift.



frame
Proposed / H4Q4: 29.72dB (+1.65)
H4Q2: 28.97dB (+0.90)
Existing / H2Q2: 28.07dB (0.00)
FLOWER GARDEN (M=3, N=12)



frame
Proposed / H4Q4: 29.11dB (+2.02)
H4Q2: 28.11dB (+1.02)
Existing / H2Q2: 27.09dB (0.00)
MOBILE & CALENDER (M=3, N=12)

Fig.2 SNR(Y) of each frame and average of them (coding: SM3, 4Mbps). Reference image is produced by 32x32DCT+16x16IDCT.

5 CONCLUSION We have proposed new motion compensation techniques for scaled down pictures in frequency domain scaling decoder and confirmed their effectiveness. (*Notice: This work has been accomplished during the author had been dispatched to G.C. Technology Co.*.)

REFERENCES

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[4] "Test Model 3 (TM3) / draft", Test Model Editing Committee, ISO-IEC /JTC1 /SC29 /WG11, MPEG92 /N0328, CCITT SG XV, AVC-400b, (Dec. 1992)

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