CCITT SG XV
Working Party XV/1

Document #81
March 1986

Specialst Group on Coding for Visual Telephony

English only

Source: NTT, KDD, NEC AND FUJITSU

Title: COMMENTS ON CONDITIONAL MOTION COMPENSATED FRAME INTERPOLATION

1. Introduction

In this Contribution, we shall discuss the advantages and disadvantages of conditional motion compensated interpolation (referred to hereafter simply as " CMI "). Figure 1 gives a schematic diagram of this CMI coding algorithm.

2. Advantage of CMI

(1) Improvement of Coding Efficiency

The advantage of CMI is that we can increase the predicion efficiency for interpolative frame, and hence we can increase the total number of bit which should be assigned to ordinary extrapolative prediction frame. The ratio of assigned bit to extrapolative prediction and CMI can be assumed aproximately in order of 7 : 3 or 8 : 2. As a result, the number of bits used per extrapolative frame increases by approximately 40 %.

At the same time, however, the frame dropping rate doubles, so the amount of motion increases by a corresponding amount, and the prediction efficiency falls (actually, there should be no decrease of efficiency provided we remain within the range of motion compensation, but in practice, this factor does not in any case improve the situation).

The increase in the number of bits used and the decrease of extrapolative prediction efficiency therefore cancel each other out, but usually the factor which increase gain is the dominant. For example, if there is a 40% surplus of bits available, the gain sometimes increases provided the prediction efficiency does not fall below 71%. Assuming the decrease of prediction efficiency is 90% (which means the number of significant picture elements increases by 10%); a result can be expected equivalent to a 26% increase in efficiency.

3. Disadvantages of CMI

(1) Extra hardware

For CMI, motion interpolation unit is required as shown in Figure 1 (such a unit would be necessary anyway if the receiver carries out motion interpolation processing; but in this case, as it is not actually required on the transmitting side, it must be regarded as a piece of extra hardwadre).

If we can assume the coding unit 3 is a circuit which processes the extrapolative data for 1 frame in 1 frame interval, and the circuit can be shared as the coding unit 2 with the result that there is no increase in hardware for this part. However, a control mechanism would be necessary for changing over the 2 types of input signals to the encoder (extrpolative prediction error and interpolative prediction error), which does involve some extra hardware.

(2) Additional delay

In CMI, interpolated frame decoding cannot take place until at least the decoding of the next frame is complete (this is also true when motion interpolation is performed on the receiving side only), and therefore there is always a delay of 1 frame.

Further, if the encoder is used for a dual purpose as described above in order to economize on hardware, the delay time is increased by one more frame. This means that compared to the case of ordinary extrapolative prediction alone, there is a delay of 2 frames.

4. General Evaluation

With CMI, there is certainly a longer delay, but even in the case of extrapolative prediction alone, the difference is only 1 frame if the frame dropping rate improves resolution in the time direction. It is difficult to say which method gives a better overall quality, only by simulation evaluation.

At the same time, it is practically certain that CMI can improve the coding efficiency. Even if any sort of adaptive control of DCT with sophisticated hardware is used, for example, it might be difficult to increase the coding efficiency by 30%, but the extra hardware required for CMI to produce the same effect would probably be no greater.

In conclusion, it would appear that from the viewpoint of the coding efficiency CMI can evidently be incorpolated, although it seems fairly obvious, extra hardware and increased delay go together. The question of whether or not to adopt CMI, therefore, depends on whether the corresponding increase of picture quality is really necessary.

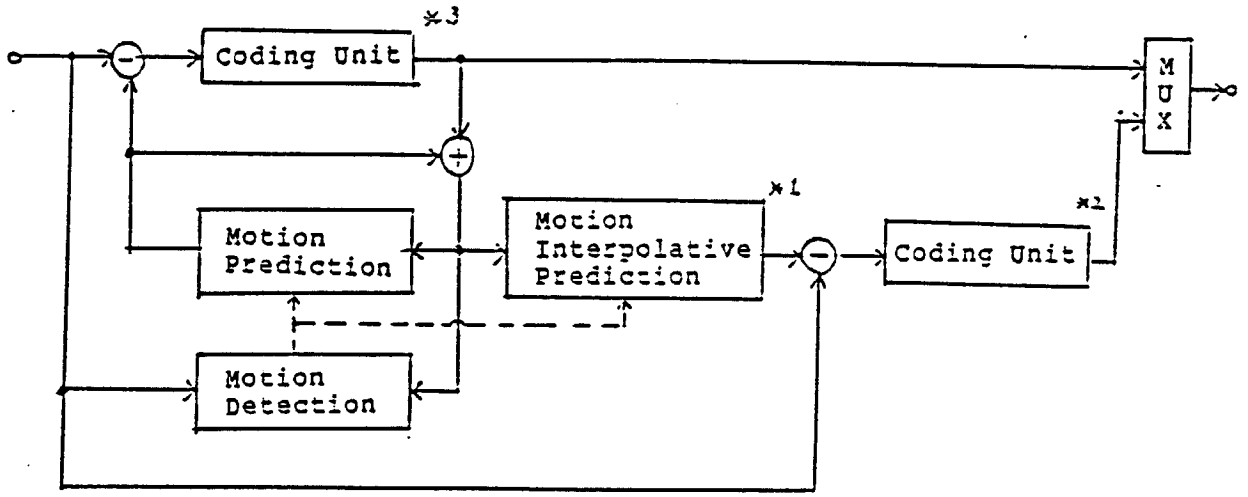

Fig. 1 Schematic diagram of CMI coder

Table 1 Comparison of Delays with a Frame Dropping Rate of n:1

Extrapolative prediction only	n-1 frames
Motion compensated interpolation (CMI, coding units in parallel)	n frames
CMI (dual use of circuit)	n+1 frames

Annex to #81

Table. 1 Simulation Results

Test Sequence	Without CMI	With CMI
Miss Anerica (140th frame)	39.57 dB 10 HZ	39.98 dB (39.05 dB) 10 HZ
Checked Jacket (52th frame)	38.75 dB 10 HZ	38.75 dB (38.29 dB) 10 HZ
Split Screen (60th frame)	32.57 dB 7.5 HZ	33.09 dB (29.98 dB) 7.5 HZ
Trevor (140th frame)	35.24 dB 7.5 HZ	34.89 dB (32.18 dB) 7.5 HZ

in parenthesis : CMI frame