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

Document #156

November 1986

Source : NTT,KDD,NEC and FUJITSU

TITLE : BLOCK TYPE IDENTIFICATION METHOD, VARIABLE BLOCK SIZE AND OVERALL PERFORMANCE

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1. Introduction

This contribution reports upon the effectiveness of the judgements for significant/insignificant blocks and the selection of inter-frame/intra-frame blocks of hybrid coding schemes. In conjunction with this, we also provide information of the effect of these judgements for variable block size processing as proposed in Document # 93,94.

The judgement and the selection do not fall within the range of standardization but it is thought that they will be effective for picture quality improvements. On the other hand, variable blocksize processing involves processing inside coding loops, and so deliberation on this is necessary.

2. Description of the system

(1) Significant/insignificant block judgements

The first objective of this system is improvement of the coding efficiency. For flat parts such as the background of images where there is the input of signals carrying static, transform coding of these signals will generate a transform coefficient value that exceeds the threshold even for insignificant blocks. This not only results in the wasted consumption of the coding bit, but gives the "blockwise error" of the flat parts of the image and therefore become a cause of their visual deterioration. It is possible, however, to reduce this deterioration through performing significant/insignificant judgements with respect to the MC prediction error signals before DCT processing is performed.

The second objective is to perform correct judgements with respect to blocks that have both a moving part and a background part. For example, if practically whole of one block consists of background and only an extremely small part is related to the moving object, then the performance of DCT for the entire block will average the dynamic region and the static region, and the result will be that the block becomes an insignificant block. In this case, the edge of the moving image is missing to result in severe deterioration of the image.

In order to prevent the occurence of deterioration such as this, the MC prediction error signal shown in Fig. 1 is used to perform significant/insignificant judgements for the block currently being input. There are various methods available for realizing this, but the algorithm described below is adopted in Japanese Flexible Hardware under design.

The MC prediction error signal is made Y_i. Each block is divided into sub-blocks made up of 4 pixels * 4 lines and the sum of the above absolute prediction error signal is used for each sub-block unit to

determine the MC prediction error evaluation amount S_j as below.

$$S_j = \sum_{i=1}^{16} |Y_i| /16$$

(for 16 pixels in sub-block j)

The evaluation amount S_1 - S_4 with respect to the sub-blocks of the input block, is compared to the threshold T_s which is determined by the coding control part. Significant/insignificant judgements in sub-block units are then made.

if $S_j \geq T_s$ then $f(S_j) = 1$: Significant sub-block
else $f(S_j) = 0$: Insignificant sub-block

The result of this is that the current input block is judged to be an insignificant block if there is no significant sub-block in the current block, and as a significant block even if there is only one significant sub-block in the current block.

if $\sum_{j=1}^{4} f(S_j) = 0$ then $f(S) = 1$: Significant block
else $f(S) = 0$: Insignificant block

(2) Inter-frame/intra-frame selection

As was explained in the previous section, the use of part of the circuit for the significant/insignificant judgements enables inter-frame/intra-frame selection. The method for this is in approximate conformity with the reference model, but a slightly simplified way is given below.

For significant blocks, the MC prediction error evaluation amount S_m is determined by the following.

$$S_m = \sum_{j=1}^{4} S_j /4$$

The average value M_i for the significant block input signal X_i is determined by the following.

$$M_i = \sum_{i=1}^{64} X_i /64$$

This average value and the input signal X_i are used to determine the intra-frame signal evaluation amount S_r as follows.

$$S_r = \sum_{i=1}^{64} |X_i - M_i| /64$$

S_m and S_r are then used to perform the inter-frame/intra-frame judgement as follows.

if $S_m \leq T_{im}$ then $f(M) = 1$: inter-frame mode
else
if $S_m < S_r$ then $f(M) = 1$: inter-frame mode
else $f(M) = 0$: intra-frame mode

Moreover, the threshold T_{im} here is provided to preventnt the selection of the intra-frame mode regardless or how small the MC error signal is, and so prevent an increase in the number of bits required for coding in the intra-frame mode. Therefore, it is not necessarily required when it is used in conjunction with a significant/insignificant judgement circuit.

(3) Variable block size processing

The evaluation amount of the MC prediction error signals is determined in 4 * 4 sub-block units in the course of significant/insignificant judgements, and so the use of this information enables the

size of the necessary significant block to be known. The stipulations for current flexible hardware do not include those for variable block size processing but it is thought that the inclusion of this can be performed comparatively easily if one type of scan class is added.

This is shown for the case where only 4 * 4 sub-blocks within 8 * 8 block are to be made significant. At this time, the input values of those sub-blocks are quadrupled while those for other sub-blocks are made zero. Those signals are given 8 * 8 DCT conversion and only the coefficients of the positions from 1 to 16, as shown in Fig. 2(a), are important. Because of this, it is only necessary to scan the coefficient values for the positions 1 to 16 even when the coefficient values of the other positions are not zero. The values for the coefficients of other positions are forcibly set to zero. This is to say that the selection of 4 * 4 as the block size, selects the scan shown in Fig.2(a), and the receiving side is informed that this scan has been selected. Therefore, allocation such as that having 4 * 4 and 4 * 8 block processing is made for those (currently proposed) scan systems that have 8 types of coefficients, and it therefore becomes possible to incorporate variable block size processing. (Moreover, in order to indicate the valid sub-block positions in the 4 * 4 or the 4 * 8 mode, these two pieces of scan class information have 2-bit address information appended.)

In the 4 * 8 or 8 * 4 block mode, the scan class shuld be merged in a single way and so when the significant blocks in the horizontal direction are aligned, these are replaced by X-Y cordinates and DCT conversion performed as double the input signal after the significant blocks in the vertical direction have been aligned. The decoding block involves replacing the X-Y coordinates once again after inverse DCT conversion has been performed. Therefore, in the case of the 4 * 8 mode, scanning is performed as shown in Fig. 2(b) when the significant sub-blocks are aligned vertically, and also when they are aligned horizontally.

3. Simulation result

A coding experiment was performed through simulation in order to confirm the effect of the above significant/insignificant judgements,the inter-frame/intra-frame selection and the variable block size processing. The results will be shown at the meeting. (This simulation was performed using a program to simulate the operation of the flexible hardware.) The system consists of the core components and non-compatibility elements for the significant/insignificant judgements and the inter-frame/intraframe selection, etc. forming the base to which variable block size processing is either applied or not applied, and the results compared.

Judging from the results of the simulation, variable block size processing is thought to be effective for images where there are large moving parts, such as in the case of a "Split-Trevor" scenes. In addition, it was also confirmed that the "mosquito effect" is reduced for images such as "Checked Jacket" scenes.

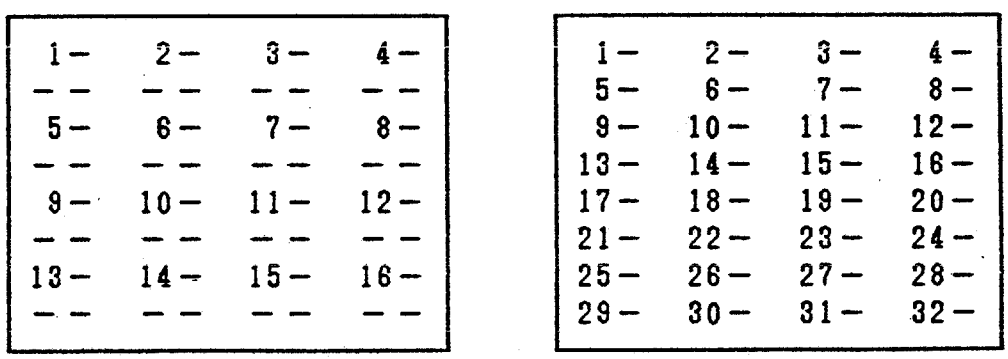
4. Conclusions and proposal

As far as significant/insignificant judgements and interframe/ intra-frame judgements are concerned they do not become objects of standardization since they are non-compatibility elements. This is reported only for information purposes because the results of the examination show their effectivenes.

With respect to variable block size processing, it is thought that the results of performing new experiments on the basis of Document #93,94

had some effect. Accordingly, work for the incorporation of this processing into hardware is being forwarded in Japan as one part of autonomous work concerning functions of CODEC for international field trials currently being planned. However, this part relates to the processing inside coding loops and is therefore proposed as one element for "future inclusion" and for which further investigation are requested.

[Ref.]
(1) CCITT SG XV, SGCV Document #93 "The use of a N-DCT device to perform a N/2-DCT", France
(2) CCITT SG XV, SGCV Document #94 "Variable blocksize hybrid coding scheme", France



(- : don't care)

(a) 4 * 4 block mode (b) 4 * 8 block mode

Figure 2. Scanning for Variable Block Size Processing

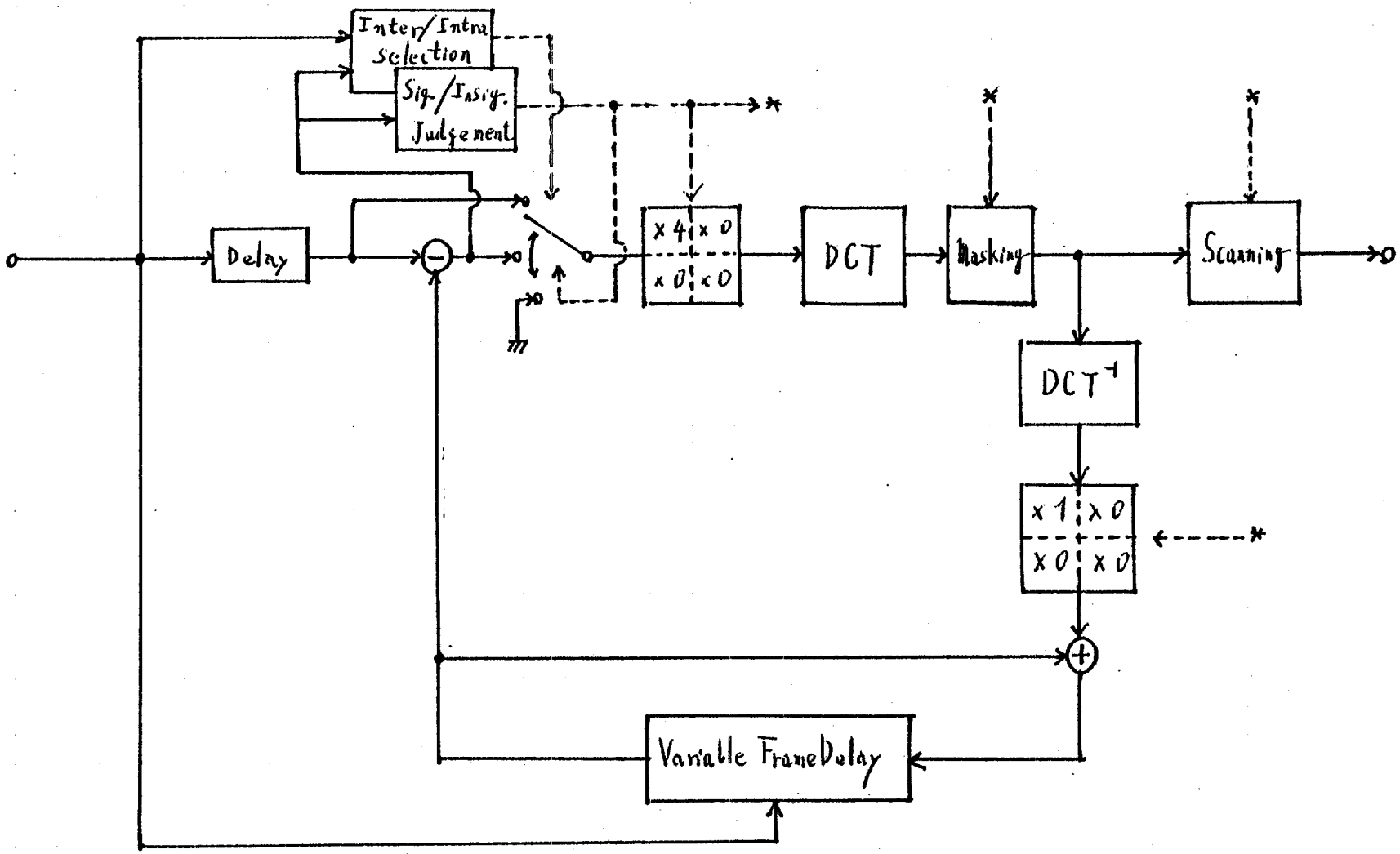


Figure 1. Significant/insignificant, Inter-frame/intra-frame and Variable Block Size Processing