CCITT SG XV

Doc no # 170
November, 1986

Specialists Group on Coding
for Visual Telephony

Title: Coding of coefficients with a two-dimensional table

Source: FRG

**1. Coding technique**

In the reference model no 2 quantized and scanned transform coefficients are coded with a single VLC. This VLC is assigned to every coefficient (including zeros) separately, i.e. every coefficient produces a code word.

It is possible to save 3-4 bits per coded block compared with the reference model no 2 by using a two-dimensional coding table (Fig. 1) together with a diagonal scan. The "end of block" word is not shown in Fig. 1. The table uses the statistical property between the number of consecutive zeros (run-length) and the magnitude of the following nonzero coefficient. These parameters are coded in common, defining the two entries of the table.

Only the marked area in Fig. 1 is used, which reduces the number of code words.

**Examples**

18 zeros and a "3" are coded as
(i, j) = (15, 0) 16 zeros
(i, j) = (2, 3) 2 zeros and a "3"

7 zeros and a "6" are coded as
(i, j) = (6, 0) 7 zeros
(i, j) = (0,6) no zero and a "6"

Assuming 256 different levels for the quantized coefficients (excluding the DC-coefficient in intra-frame mode), a two-dimensional coding table needs 12 bits as an input (Fig. 2)
A table with a variable length code is given in the appendix.

**2. Conclusions**

The obtained gains in coding efficiency using a two-dimensional coding table for non-fixed blocks are:
- 18 % for "checked jacket"
- 14 % for "split screen/Trevor White"

compared with the reference model no 2.

Only one scanning class with zig-zag scan is used.

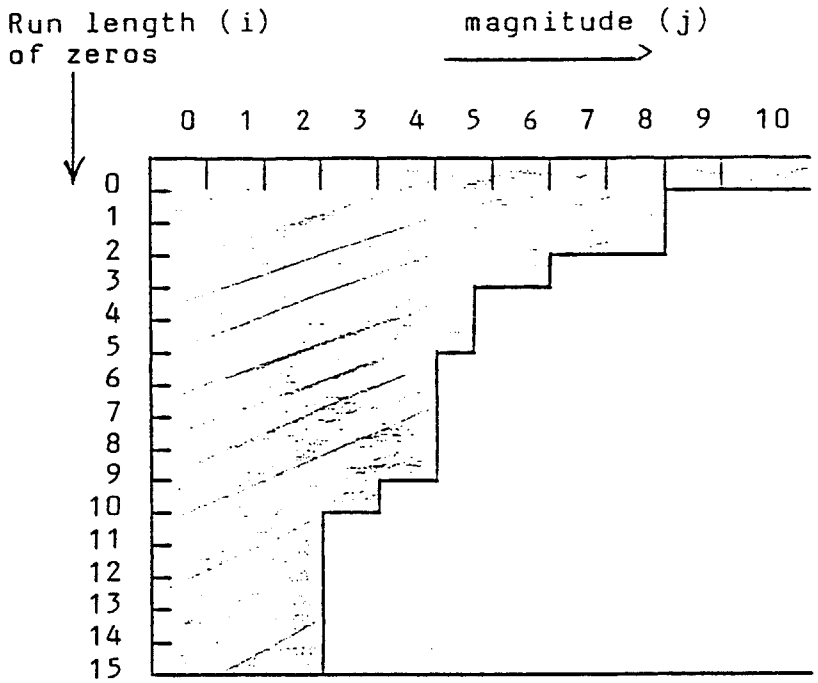


Fig. 1 2-dimensional VLC table

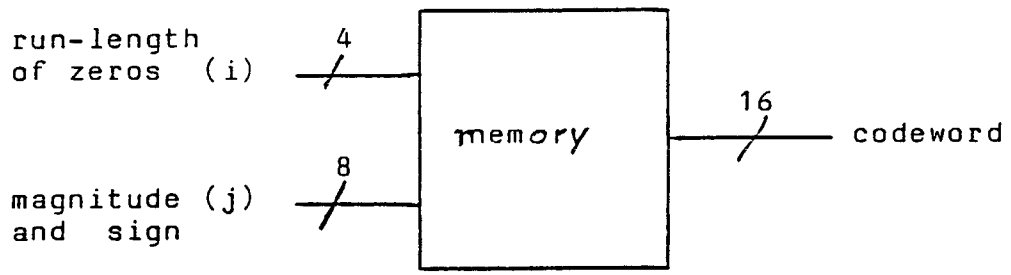


Fig. 2 Implementation of VLC table

Appendix

Two-dimensional coding table

Explanations:

s : 1 bit for sign
- : don't care
+ : fixed length code
i : table entry 1 (run-length of zeros)
j : table entry 2 (magnitude)

| No | j | i | code word | length |
|---|---|---|---|---|
| 1 | - | - | 11 (end of block) | 2 |
| 2 | 1 | 0 | 010s | 4 |
| 3 | 1 | 1 | 1000s | 5 |
| 4 | 1 | 2 | 1001s | 5 |
| 5 | 2 | 0 | 1010s | 5 |
| 6 | 0 | 15 | 10110 | 5 |
| 7 | 1 | 3 | 10111s | 6 |
| 8 | 1 | 4 | 01100s | 6 |
| 9 | 1 | 5 | 01101s | 6 |
| 10 | 2 | 1 | 01110s | 6 |
| 11 | 3 | 0 | 01111s | 6 |
| 12 | 1 | 6 | 001000s | 7 |
| 13 | 1 | 7 | 001001s | 7 |
| 14 | 1 | 8 | 001010s | 7 |
| 15 | 1 | 9 | 001011s | 7 |
| 16 | 2 | 2 | 001100s | 7 |
| 17 | 3 | 1 | 001101s | 7 |
| 18 | 4 | 0 | 001110s | 7 |
| 19 | 5 | 0 | 001111s | 7 |
| 20 | 1 | 10 | 0001000s | 8 |
| 21 | 1 | 11 | 0001001s | 8 |
| 22 | 1 | 12 | 0001010s | 8 |
| 23 | 1 | 13 | 0001011s | 8 |
| 24 | 1 | 14 | 0001100s | 8 |
| 25 | 2 | 3 | 0001101s | 8 |
| 26 | 2 | 4 | 0001110s | 8 |
| 27 | 6 | 0 | 0001111s | 8 |
| 28 | 1 | 15 | 00001000s | 9 |
| 29 | 2 | 5 | 00001001s | 9 |
| 30 | 3 | 2 | 00001010s | 9 |
| 31 | 4 | 1 | 00001011s | 9 |
| 32 | 7 | 0 | 00001100s | 9 |
| 33 | 8 | 0 | 00001101s | 9 |
| 34 | 2 | 6 | 00001110s | 9 |
| 35 | 2 | 7 | 000001000s | 10 |
| 36 | 2 | 8 | 000001001s | 10 |
| 37 | 2 | 9 | 000001010s | 10 |
| 38 | 3 | 3 | 000001011s | 10 |
| 39 | 4 | 2 | 000001100s | 10 |
| 40 | 5 | 1 | 000001101s | 10 |
| 41 | 6 | 1 | 000001110s | 10 |
| 42 | 0 | 0 | 0000011111 | 10 |

| | | | | |
|---|---|---|---|---|
| 43 | 2 | 10 | 0000011110s | 11 |
| 44 | 3 | 4 | 0000001000s | 11 |
| 45 | 3 | 5 | 0000001001s | 11 |
| 46 | 4 | 3 | 0000001010s | 11 |
| 47 | 5 | 2 | 0000001011s | 11 |
| 48 | 7 | 1 | 0000001100s | 11 |
| 49 | 2 | 11 | 0000001101s | 11 |
| 50 | 2 | 12 | 0000001110s | 11 |
| 51 | 2 | 13 | 0000001111s | 11 |
| 52 | 3 | 6 | 00000001000s | 12 |
| 53 | 3 | 7 | 00000001001s | 12 |
| 54 | 3 | 8 | 00000001010s | 12 |
| 55 | 4 | 4 | 00000001011s | 12 |
| 56 | 4 | 5 | 00000001100s | 12 |
| 57 | 5 | 3 | 00000001101s | 12 |
| 58 | 6 | 2 | 00000001110s | 12 |
| 59 | 8 | 1 | 00000001111s | 12 |
| 60 | ≥ 9 | 0 | 00001111s+++++++ | 16 |
| 61 | 0 | 1 | 000000000100000-- | 16 |
| 62 | 0 | 2 | 000000000100001-- | 16 |
| 63 | 0 | 3 | 000000000100010-- | 16 |
| 64 | 0 | 4 | 000000000100011-- | 16 |
| 65 | 0 | 5 | 000000000100100-- | 16 |
| 66 | 0 | 6 | 000000000100101-- | 16 |
| 67 | 0 | 7 | 000000000100110-- | 16 |
| 68 | 0 | 8 | 000000000100111-- | 16 |
| 69 | 0 | 9 | 000000000101000-- | 16 |
| 70 | 0 | 10 | 000000000101001-- | 16 |
| 71 | 0 | 11 | 000000000101010-- | 16 |
| 72 | 0 | 12 | 000000000101011-- | 16 |
| 73 | 0 | 13 | 000000000101100-- | 16 |
| 74 | 0 | 14 | 000000000101101-- | 16 |
| 75 | 2 | 14 | 000000000101110s- | 16 |
| 76 | 2 | 15 | 000000000101111s- | 16 |
| 77 | 3 | 9 | 000000000110000s- | 16 |
| 78 | 3 | 10 | 000000000110001s- | 16 |
| 79 | 4 | 6 | 000000000110010s- | 16 |
| 80 | 4 | 7 | 000000000110011s- | 16 |
| 81 | 4 | 8 | 000000000110100s- | 16 |
| 82 | 4 | 9 | 000000000110101s- | 16 |
| 83 | 5 | 4 | 000000000110110s- | 16 |
| 84 | 5 | 5 | 000000000110111s- | 16 |
| 85 | 6 | 3 | 000000000111000s- | 16 |
| 86 | 7 | 2 | 000000000111001s- | 16 |
| 87 | 8 | 2 | 000000000111010s- | 16 |