Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a transform coding apparatus performing band compression of image data using linear transform coding system.

Description of the Prior Art

FIG. 1 is a block diagram illustrating a transform coding apparatus in the prior art disclosed, for example, in W.H. CHEN, W.K. PRATT, "Scene Adaptive Coder", (IEEE Transactions on communications, vol. COM-32, No. 3, March 1984). In FIG. 1, numeral 1 designates a blocking section for blocking input signals, numeral 2 designates a linear transform section for performing two-dimensional linear transform of the block signals, numeral 3 designates a scan transform section for rearranging signal series within the block, numeral 4 designates a quantization, numeral 5 designates a coding section, numeral 6 designates a transmission buffer, and numeral 7 designates a coding control section.

Next, operation will be described. The blocking section 1 inputs digitized input image signals 101 by one frame, and divides the signals into two-dimensional blocks which have n pixels in the horizontal and vertical directions (n: natural number, for example, n = 4, 8, 16). The linear transform section 2 applies two-dimensional linear transform (for example, orthogonal transform such as discrete cosine transform) to the blocked image signals 102, and produces transform coefficient blocks 103 in space frequency region. In this case, the two-dimensional discrete cosine transform, for example, of 8 x 8 pixel blocks f (x, y) (x, y = 0, 1, ..., 7) can be given by following formula.

$$F(u, v) = \frac{1}{4} C(u)C(v) \sum_{x=0}^{7} \sum_{y=0}^{7} f(x, y)$$

$$\times \cos\left[\frac{\pi u(2x+1)}{16}\right] \cos\left[\frac{\pi v(2y+1)}{16}\right]$$

for u, v = 0, 1, ..., 7, where

$$C(u), C(v) = \begin{cases} \frac{1}{\sqrt{2}} & (\text{for } u, v = 0) \\ 1 & (\text{for } u, v = 1, 2, \ldots, 7) \end{cases}$$

where x, y: coordinates in the pixel region, u, v: coordinates in the transform region.

Property of the transform coefficient blocks F(u, v) will be described based on FIG. 2. Values of F(u, v) indicate what degree become respective space frequency components included in the blocked image signals 102. The frequency in the horizontal direction becomes high as the value of u becomes large, and the frequency in the vertical direction becomes high as the value of v becomes large. That is, the value of F(0, 0) corresponds to the intensity of the DC component of the blocked image signal 102, and the value of F(7, 7) corresponds to the intensity of the AC component having high frequencies in both the horizontal and vertical directions. Consequently, for a monotony image block such as the background where variation of values of pixels is little, significant coefficients of non-zero appear only at lower frequency components and zero coefficients appear at most of higher frequency components. On the contrary, for an image block of the edge portion or the like where variation of values of pixels is much, significant coefficients of non-zero appear not only at lower frequency components but also at higher frequency components.

Next, the scan transform section 3 rearranges the transfer coefficients within the transfer coefficient block 103, for example, in the order of arrow shown in FIG. 2, and outputs transform coefficient series 104. In the foregoing 8 x 8 pixel block, the coefficient series of consecutive 64 coefficients is outputted for one block. The

rearrangement is performed by zigzag scanning from transform coefficients of lower frequency components where significant coefficients are liable to occur to transform coefficients of higher frequency components where significant coefficients are not liable to occur, so that the significant coefficients continue at front half and the zero coefficients continue at rear half as much as possible. Next, the quantization section 4 quantizes the transform coefficient series 104 in given quantization step size 109, and outputs quantized level series Q(u, v) 105. The coding section 5 allocates codes to the quantized level series 105, and outputs coded data 106 to the transmission buffer 6.

The two-dimensional variable length coding will now be described as an example of code allocating method. This is performed in that the number of consecutive zero quantized level (hereinafter referred to as "run") and the non-zero quantized levels are combined for the quantized level series 105, and one Huffman code is allocated for the combined event (run level). For example, in the case of the quantized level series shown in FIG. 3, the event (run level) becomes as follows.

(0, 20), (2, 15), (4, 5), (3, 2), (7, 1), EOB

Where EOB is a mark indicating that non-zero quantized level does not exists since then and zero quantized level continue until the end of the block. Consequently, in the case of the quantized level series, the predetermined Huffman codes are allocated respectively to the six events including the EOB.

Next, the transmission buffer 6 smoothes the varying the amount of the coded bits and transmits the code 107 at constant rate to the transmission line. The coding control section 7 performs feedback control of quantization step size 109 adaptively among buffer occupancy 108 being data residual quantity in the transmission buffer 6, and outputs it to the quantization section 4. That is, when the buffer occupancy 108 is much, in order to decrease the amount of the coded bits, the quantization step size 109 is made large and the input image is quantized coarsely. On the contrary, when the buffer occupancy 108 is little, in order to increase the amount of the coded bits, the quantization step size 109 is made small and the input image is quantized finely. Since the number of non-zero quantized levels is significantly different depending on whether the quantization step size 109 is large or small, the amount of the coded bits varies significantly from several ten times to several thousand times.

EP-A-0 260 748 defining the closest prior art from which the invention proceeds discloses a device for bit-rate reduction which is suited for a transform coding apparatus of the type described above. This known apparatus, once provided with said device, comprises partitioning means for partitioning an input signal series into signal blocks, linear transform means for performing a linear transform operation on the signal blocks and for obtaining a series of transform coefficients in sequence from the lower frequency components to the higher frequency components, quantization means for quantizing in sequence each of the transform coefficients in the series of transform coefficients outputted from the linear transform means, counting means for counting the number of consecutive zero quantized levels in the quantized transform coefficients quantized by the quantization means and for outputting the count values thereof, threshold determining means for determining the threshold value of the number of consecutive zero quantized levels to be transmitted, zero quantized level output means for outputting zero quantized levels when activated, coding means for coding the outputs of the quantization means, a transmission buffer for storing codes outputted by the coding means, and control means for determining the size of the quantization step used by the quantization means based on the buffer occupancy of said transmission buffer.

FIG. 4 is a block diagram showing another transform coding apparatus in the prior art corresponding to the transform coding apparatus described in EP-A-0267578. In FIG. 4, numeral 10 designates a decision section allowing only the transform coefficients within the prescribed transmission range to pass, numeral 11 designates a comparison section comparing the transform coefficient with the threshold value, numeral 12 designates a transmission range determining section for determining the transmission range of the transform coefficient, numeral 13 designates a threshold setting section for setting the threshold value, and numeral 14 designates a control section for determining the quantization characteristics and the threshold value.

Next, operation will be described. The blocking section 1 inputs digitized input image signals 101 by one frame, and divides the signals into two-dimensional blocks which have n pixels in the horizontal and vertical directions (n: natural number, for example, n = 4, 8, 16). The linear transform section 2 applies two-dimensional linear transform (for example, orthogonal transform such as discrete cosine transform) to the blocked image signals 102, and produces transform coefficient blocks 103 in space frequency region.

Next, the comparison section 11 compares the transform coefficient block 103 with the threshold value 113 given from the threshold setting section 13, and outputs the decision results 112 of which is large. The transmission range determining section 12 totalizes the decision results 112 of which is large per each block, and determines to which coefficient the transmission should be performed and outputs the transmission range 114. That is, the transmission range determining section 12 totalizes the decision results 112 of which is large in 64 pieces obtained for the 64 coefficients in the 8 x 8 blocks. As a result, if many decision results indicate

that the transform coefficient block 103 is less than the threshold value 111, only lower frequency components may be transmitted and therefore the transmission range 114 is small. On the contrary, if many decision results indicate that the transform coefficient block 103 is more than the threshold value 111, not only lower frequency components but also higher frequency components must be transmitted and therefore the transmission range 114 becomes large. The scan transform section 3 rearranges the transform coefficients within the transform coefficient block 103, for example, in the order to arrow shown in FIG. 2, and outputs transform coefficient series 104. The rearrangement is performed by zigzag scanning from transform coefficients of lower frequency components where significant coefficients are liable to occur to transform coefficients of higher frequency components where significant coefficients are not liable to occur, so that the significant coefficient series continues as long as possible. Next the decision section 10 outputs only the transform coefficients 110 of the transform coefficient series 104 within the given transmission range 114. The quantization section 4 quantizes the transform coefficients 110 in given quantization characteristics 115, and outputs quantized levels 105. The coding section 5 allocates codes based on the quantization characteristics 115 used in the quantization section 4, the quantized levels 105 and the transmission range 114, and transmits the codes 106 to the transmission line or the like. Also the control section 14 controls the quantization characteristics 115 and the threshold value 113 adaptively by the amount of the coded bits of the input image. That is, when the input image is quantized coarsely and the amount of the coded bits is decreased, both the quantization characteristics 115 and the threshold value 113 are outputted in large values. On the contrary, when the input image is quantized finely and the amount of the coded bits is increased, both the quantization characteristics 115 and the threshold value 113 are outputted in small values.

The transform coding apparatus in the prior art shown in FIG. 1 has problems in that the quantization must be performed for any coefficient, and the amount of the coded bits varies significantly depending on whether the quantization step size is large or small and therefore the control of the coding is difficult.

Also the transform coding apparatus in the prior art shown in FIG. 4 has problems in that although the non-zero transform coefficients to be coded and transmitted are limited, all transform coefficients must be obtained in order to estimate the coefficient transmission range, and therefore the processing time required for the linear transform cannot be reduced.

SUMMARY OF THE INVENTION

In order to solve the above-mentioned problems in the prior art, an object of the present invention is to provide a transform coding apparatus wherein the coefficient transmission range is determined corresponding to the quantized level series within the transform block, and the processing time required for the linear transform and the quantized is reduced and the variation of the amount of the coded bits is decreased.

In accordance with a first aspect of the invention, there is provided a transform coding apparatus wherein a linear transform operation is performed on an input signal series, and transform coefficients are quantized and coded in sequence from the lower frequency components to the higher frequency components in the transform region, said transform coding apparatus comprising:

partitioning means for partitioning said input signal series into signal blocks;

linear transform means for performing a linear transform operation on the signal blocks and for obtaining a series of transform coefficients in sequence from the lower frequency components to the higher frequency components;

quantization means for quantizing in sequence each of said transform coefficients in said series of transform coefficients outputted from said linear transform means;

counting means for counting the number of consecutive zero quantized levels in the quantized transform coefficients quantized by said quantization means and for outputting the count values thereof;

threshold determining means for determining the threshold value of the number of consecutive zero quantized levels to be transmitted;

zero quantized level output means for outputting zero quantized levels when activated;

coding means for coding the outputs of said quantization means;

a transmission buffer for storing codes outputted by said coding means; and

control means for determining the size of the quantization step used by said quantization means based on the buffer occupancy of said transmission buffer;

characterized by

decision means for obtaining one additional transform coefficient from said linear transform means when and only when the count value of consecutive zero quantized levels is less than the threshold value, and for activating said zero quantized level output means for subsequent transform coefficients when said count value equals said threshold value; and

said threshold determining means determining said threshold value based on the buffer occupancy of said transmission buffer.

In accordance with a further aspect of the present invention, there is provided a transform coding apparatus wherein a two-dimensional linear transform operation is performed on an input signal series, and transform coefficients are quantized and coded in sequence from lower frequency components to higher frequency components in the transform region, said transform coding apparatus comprising:
partitioning means for partitioning said input signal series (101) into input signal blocks;
first transform means for applying a one-dimensional linear transform operation to the partitioned input signal blocks so as to obtain a one-dimensional transform coefficient block;
second transform means for further applying an orthogonal one-dimensional linear transform operation to the one-dimensional transform coefficient block so as to obtain a series of two-dimensional cofficients in sequence from the lower frequency components to the higher frequency components;
quantizing means for quantizing each two-dimensional transform coefficient outputted from said second transform means;
counting means for counting the number of consecutive zero quantized levels in the values of the quantized transform coefficients quantized by said quantizing means and for outputting the count values thereof;
threshold determining means for determining the threshold of the number of consecutive zero quantized levels to be transmitted;
event storage means for storing as events of the block the value of quantized transform coefficients which are non-zero quantized levels and the number of consecutive zero quantized levels counted by said counting means before the non-zero quantized levels appear;
coding means for allocating codes to each event stored in said event storage means;
a transmission buffer for storing codes outputted by said coding means; and
control means for determining size of quantization step used by said quantization means based on the buffer occupancy of said transmission buffer;
characterized by
decision means for obtaining one further two-dimensional transform coefficient from said second transform means when said value of consecutive zero quantized levels is less than said threshold value and for terminating the second transform and quantizing process for subsequent two-dimensional transform coefficients when said count value equals said threshold value; and
said threshold determining means determining said threshold value based on the buffer occupancy of said transmission buffer.

Further advantageous embodiments of the invention are defined in the sub-claims.

In the transform coding apparatus according to the invention, linear transform is performed for the input signal series, and the transform coefficients are quantized and coded in sequence from that of lower frequency components to that of higher frequency components in the transform region.

And then in the transform coding apparatus according to the invention, the linear transform and the quantization are performed in combination by the given order for the input signal block, and the number of the consecutive zero quantized level is counted and if the count value exceeds the given threshold value the linear transform is not performed but any residual quantization output is made zero. That is, based on the number of the consecutive zero quantized levels, decision is performed whether next transform coefficient is estimated by the linear transform or not. If the decision is in that the transform coefficient is not estimated, the value of the quantization output is made zero.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a transform coding apparatus in the prior art;
FIG. 2 is an explanation diagram illustrating property of a transform coefficient block;
FIG. 3 is an explanation diagram illustrating allocation of codes;
FIG. 4 is a block diagram showing another transform coding apparatus in the prior art;
FIG. 5 is a block diagram showing a transform coding apparatus as a first embodiment of the invention;
FIG. 6 is a flow chart illustrating operation of the transform coding apparatus shown in FIG. 5;
FIG. 7 is a block diagram showing a transform coding apparatus as a second embodiment of the invention;
FIG. 8 is a flow chart illustrating operation of the transform coding apparatus shown in FIG. 7;
FIG. 9 is a block diagram showing a transform coding apparatus as a third embodiment of the invention;
FIG. 10 is a flow chart illustrating operation of the transform coding apparatus shown in FIG. 9;
FIG. 11 is a block diagram showing a transform coding apparatus as a fourth embodiment of the invention; and

FIG. 12 is a flow chart illustrating operation of the transform coding apparatus shown in FIG. 11.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of the invention will now be described based on FIG. 5 and FIG. 6. In FIG. 5, numeral 21 designates a linear transform section for performing linear transform of blocked signals in the predetermined order, numeral 22 designates a counter for counting the number of the consecutive zero quantized levels, numeral 23 designates a decision section for comparing the count value with the threshold value and performing decision whether the linear transform of next coefficient should be performed or not, numeral 24 designates a zero coefficient output section for outputting the zero quantized levels of the given number, and numeral 25 designates a threshold setting section for setting the threshold value. Constitution of the embodiment is similar to that shown in FIG. 4 except that as above described.

Next, operation will be described. In similar manner to the apparatus shown in FIG. 4, digitized input image signals 101 by one frame are divided into two-dimensional blocks by the blocking section 1, and become blocked image signals 102. The linear transform section 2 applies the linear transform to the blocked image signals 102 in the order shown by arrow in FIG. 2 for example, and outputs a transform coefficient 121 (step ST11). The quantization section 4 quantizes the transform coefficients 121 in given quantization characteristics 115, and outputs quantization coefficients 120 (step ST12). The counter 22 counts the number of the consecutive quantized levels 120 having value zero (steps ST13, ST15). If the non-zero quantized level 120 is outputted from the quantization section 4, the count value 122 is reset and becomes zero (step ST14). The decision section 23 compares the inputted count value 122 with the threshold value 123 given from the threshold setting section, and process is branched to following processing (step ST16).

(I) If count value < threshold value, the decision section 23 outputs the decision result 124 indicating that next coefficient is estimated by the linear transform to the linear transform section 21. Then the linear transform section 21 performs the linear transform continuously.

(II) If count value = threshold value, the decision section 23 outputs the decision result 124 indicating that the linear transform is not performed from next coefficient to last coefficient to the linear transform section 21, and outputs the number 125 of coefficients where the linear transform is not performed. The zero coefficient output section 24 for outputting the zero quantized level series 126 of the given number 125 to the coding section 5 (step ST17).

As already described, in general, since the intensity of the transform coefficients becomes weak from lower frequency components to higher frequency components, the quantized levels become zero consecutively with high probability at higher frequency components. Consequently, when the quantization is performed in the order from lower frequency components to higher frequency components and the zero quantized levels are counted, at the small threshold value, since the above-mentioned condition (II) is satisfied at coefficients of relatively lower frequency components, the processing time required to estimate the transform coefficients can be significantly reduced.

The coding section 5 allocates codes based on the quantization characteristics 115 used in the quantization section 4, the quantization coefficients 120 and the zero quantization coefficient series 126, and transmits the codes 128 to the transmission line or the like. Also the control section 14 controls the quantization characteristics 115 and the threshold value 127 adaptively by the amount of the coded bits of the input image. That is, in order to decrease the amount of the coded bits of the input image, since the quantization must be effected coarsely, the quantization characteristics 115 are made large and the threshold value 127 is made small so that the transmission to higher frequency components is not performed. On the contrary, in order to increase the amount of the coded bits, since the quantization must be effected finely, the quantization characteristics 115 are made small and the threshold value 127 is made large so that the transmission to higher frequency components is performed and the picture quality of the decoded image is not deteriorated.

Although combination of the two-dimensional linear transform and the quantization has been described in the above embodiment, similar effects can be obtained also in combination of the one-dimensional or three-dimensional linear transform and the quantization.

A second embodiment of the invention will be described based on FIG. 7 and FIG. 8. Numeral 31 designates a quantization section for controlled by decision result 138 and performing quantization, numeral 32 designates a threshold setting section for setting the threshold value based on buffer occupancy 134, and numeral 33 designates a decision section for comparing the count value 136 of the counter 22 with the threshold value 137.

Next, operation will be described. Digitized input image signals 101 by one frame are blocked and then subjected to linear transform. The scan transform section 3 rearranges the transform coefficients, and the quantization section 31 quantizes the transform coefficients 104 by the given quantization step size 135 and

outputs the quantization coefficient series 131 (step ST22). The coding control section 7 determines the quantization step size 135 from the buffer occupancy 134 of the transmission buffer 6, and outputs it to the quantization section 31. The threshold setting section 32 determines the threshold value 137 also from the buffer occupancy 134, and outputs it to the decision section 33. The counter 22 counts the number of the consecutive zero values among the quantized level series 131, and if the non-zero quantized level is outputted from the quantization section 31, the count value 136 is reset and becomes zero (step ST24). The decision section 33 compares the inputted count value 136 with the threshold value 137 given from the threshold setting section 32, and outputs the decision result 138 to the quantization section 31. The quantization section 31 is branched to following processing according to the decision result 138 (step ST26).

(I) If the decision result 138 indicates that count value < threshold value, next coefficient is quantized also in the same quantization step size 135.

(II) If the decision result 138 indicates that count value = threshold value, the quantization is not performed and the zero quantized levels are outputted from next coefficient to the last coefficient.

In the FIG. 3, for example, when the threshold value is set to 4 or 5, the event and the number of the coefficients performing the quantization become as follows.

When the threshold value is 4, the event becomes (0, 20), (2, 15), EOB, and the number of the coefficients performing the quantization becomes eight from Q(0, 0) to Q(2, 1).

When the threshold value is 5, the event becomes (0, 20), (2, 15), (4, 5), (3, 2), EOB, and the number of the coefficients performing the quantization becomes 18 from Q(0, 0) to Q(3, 2).

As already described, in general, since the intensity of the transform coefficients becomes weak from lower frequency components to higher frequency components, the quantized levels Q(u, v) being a result of the quantization become zero consecutively with high probability at higher frequency components. Consequently, when the quantization is performed in the order from lower frequency components to higher frequency components and the zero quantized levels are counted, at the small threshold value (111), since the above-mentioned condition (II) is satisfied at coefficients of relatively lower frequency components, the number of the operations and the amount of the coded bits to enable the stopping of quantization and coding of the transform coefficients of higher frequency components can be reduced. Consequently, in the apparatus of the prior art shown in FIG. 1, since the amount of the coded bits is controlled only by the quantization step size 109, the amount of the coded bits varied rapidly depending on whether the quantization step size 109 is large or small, however, the threshold setting section 32 controls the threshold value 137 adaptively thereby the rapid variation of the amount of the coded bits can be suppressed. That is, when the buffer occupancy 134 is little, the threshold value 137 is made small and the coefficient transmission range is limited thereby the amount of the coded bit at the small quantization step size 135 can be suppressed. On the contrary, when the buffer occupancy 134 is large, the threshold value 137 is set large thereby coefficients to higher frequency components can be transmitted and the deterioration of the picture quality of the decoded image can be prevented.

Also according to this embodiment, since all transform coefficients need not be necessarily quantized, when the quantization is executed using the digital signal processor or the like, the number of the operations can be significantly reduced and further effects can be obtained.

Although combination of the two-dimensional linear transform and the quantization has been described in the above embodiment, similar effects can be obtained also in combination of the one-dimensional or three-dimensional linear transform and the quantization.

As above described, according to this embodiment, since decision whether the subsequent transform coefficients should be quantized and coded or not is performed depending on the number of the consecutive zero quantized levels, effects are obtained in that the processing time and the amount of the coded bit required for the quantization can be significantly reduced without deteriorating the picture quality of the decoded image.

Next, a third embodiment of the invention will be described based on FIG. 9 and FIG. 10. In FIG. 9, numeral 42 designates an event storage section for temporarily storing an event comprising value of non-zero quantized level among the quantized level 131 and count value 136 at that time, and numeral 43 designates a code allocation section for allocating codes to the event.

Next, operation will be described.

Digitized input image signals 101 by one frame are divided into blocks of N x N pixels, and then subjected to linear transform. The scan transform section 3 rearranges the transform coefficients, and outputs the transform coefficient series F(n) 104 (step ST31). The coding control section 7 determines the quantization step size 135 from the buffer occupancy 134 of the transmission buffer 6, and outputs it to the quantization section 31. The threshold setting section 32 determines the threshold value 137 also from the buffer occupancy 134, and outputs it to the decision section 33. As the initial setting, the count value 136 of the counter 22 is made zero, and the storage content of the event storage section 42 is cleared, and the coefficient number i of the transform coefficient series F(n) 104 constituted by the transform coefficients of N^2 is made 1 (step ST32).

The quantization section 31 quantizes F(i) being one of the transform coefficient series F(n) 104 in the quantization step size 135, and outputs Q(i) being one of the quantized level series Q(n) 131 (step ST34). If the value of Q(i) is not zero, the event storage section 42 stores set comprising the count value 136 of the counter 22 and Q(i) being non-zero quantized level as an event. And then the counter 22 is reset and the count value 136 becomes zero (step ST36). If Q(i) is not the last quantized level, quantization of next transform coefficient is performed continuously (steps ST40, ST41). If the value of Q(i) is zero, the counter 22 adds 1 to the count value 136 (step 37). Next the decision section 33 compares the inputted count value 136 with the threshold value 137, and outputs the decision result 138 to the event storage section 42. If the decision result 138 indicates that count value (138) = threshold value (137) (step ST38), or if Q(i) is the last quantized level of the quantized level series Q(n) (step ST40), the event storage section 42 outputs the event 142 stored at present, and the processing of the pixel block terminates (step ST42). The code allocation section 43 allocates Huffman codes and adds EOB to the outputted event 142, and outputs the coded data 143 to the transmission buffer 6. On the contrary, if there is no event 142 to be outputted, since it is an insignificant block, code representing the insignificant block is outputted as the coded data 143 to the transmission buffer 6.

On the other hand, the quantization in the quantization section 31 is controlled by the decision result 138 from the decision section 33, and if count value (136) = threshold value (137), the quantization processing is terminated for the subsequent transform coefficients.

In the FIG. 3, for example, when the threshold value is set to 4 or 5, the event stored in the event storage section 42 and the number of the coefficients performing the quantization respectively become as follows.

When the threshold value is 4, since the four zero quantized levels continue from Q(5) to Q(8), the condition of terminating the quantization is satisfied and the event stored as set of the zero run and the value of the non-zero quantized level is (0, 20), (2, 15), and the number of the transform coefficients performing the quantization becomes eight from Q(1) to Q(8).

When the threshold value is 5, since the five zero coefficients continue from Q(14) to Q(18), the stored event is (0, 20), (2, 15), (4, 5), (3, 2), and the number of the coefficients performing the quantization becomes 18 from Q(1) to Q(18).

As already described, in general, since the intensity of the transform coefficients becomes weak from lower frequency components to higher frequency components, the quantized level series Q(n) 131 being a result of the quantization becomes zero consecutively with high probability as n becomes large. Consequently, as the threshold value 137 is made small, the transmission range of the coefficients is limited and the number of the coefficients requiring the quantization becomes little and the amount of the coded bits is also decreased. Consequently, if the threshold value 137 is controlled in feedback adaptively from the buffer occupancy 134 in similar manner to the quantization step size 135, the amount of the coded bits can be smoothed more finely.

According to this embodiment, since all transform coefficients are not necessarily quantized, when necessary transform coefficients only are obtained, the number of the operation to obtain the transform coefficients can be reduced and further effects can be obtained.

Although combination of the two-dimensional linear transform and the quantization has been described in the above embodiment, similar effects can be obtained also in combination of the one-dimensional or three-dimensional linear transform and the quantization.

Next, a fourth embodiment of the invention will be described based on FIG. 11 and FIG. 12. In FIG. 11, numeral 50 designates a one-dimensional linear transform section for performing one-dimensional linear transform of the blocked image signals 102, and numeral 51 designates another one-dimensional linear transform section for performing one-dimensional linear transform of outputs of the one-dimensional linear transform section 50 in other direction.

Next, operation will be described.

Digitized input image signals 101 by one frame are divided into blocks of N x N pixels by the blocking section 1. The blocked image signals 102 are subjected to, for example, the one-dimensional linear transform operation in the row direction by the one-dimensional linear transform section 50, and become one-dimensional transform coefficient block 151 having N x N elements (step ST51). As the initial setting, the count value 136 of the counter 22 is made zero, and the storage content of the event storage section 42 is cleared, and the coefficient number i of the two-dimensional transform coefficients of N^2 pieces scanned in the scan order shown in FIG. 2 is made 1 (step ST52). Next, the one-dimensional linear transform section 51 performs the one-dimensional linear transform operation in the column direction being orthogonal to the one-dimensional linear transform block 151, and one of the two-dimensional transform coefficient F(i) of the coefficient number i is outputted (step ST53). The coding control section 7 determines the quantization step size 135 from the buffer occupancy 134 of the transmission buffer 6, and outputs it to the quantization section 41. The threshold setting section 32 determines the threshold value 137 also from the buffer occupancy 134, and outputs it to the decision section 33. The quantization section 41 quantizes the transform coefficient F(i) 152 in the quan-

tization step size 135, and outputs the quantized level Q(i) 153 (step ST54). Next, decision is performed regarding whether the quantized level Q(i) is zero or not (step ST55). If the value of Q(i) is not zero, the event storage section 42 stores set comprising the count value 136 of the counter 22 and Q(i) being non-zero quantized level as an event. In this case, the counter 22 makes the count value 22 zero (step ST56). On the other hand, if the quantization coefficient Q(i) is zero in the step ST55, the counter 22 adds 1 to the count value 136 (step ST57). The decision section 33 compares the count value 136 with the threshold value 137 (step ST58), and outputs the decision result 138. If the decision result 138 indicates that the count value 136 is equal to or more than the threshold value 137, the one-dimensional linear transform section 51 and the quantization section 41 stop the processing (step ST59). Set of the number of the zero coefficients among the quantized levels and the value of the non-zero quantized levels stored in the event storage section 42 is outputted to the code allocation section 43 (step ST62). In the comparison of the count value 136 with the threshold value 137 in the decision section 33 as above described, if the count value 136 is less than the threshold value 137 or if the processing in the step ST56 terminates, the event storage section 42 performs decision whether the coefficient number i becomes N^2 or not (step ST60). If the coefficient number i is N^2, i.e., Q(i) is the last quantized level, the event storage section 42 outputs the event 154 stored at present (step ST62), and the processing of the pixel block ends. The code allocation section 43 allocates Huffman codes and adds EOB to the outputted event 154, and outputs the coded data 155 to the transmission buffer 6. On the contrary, if there is no event 155 to be outputted, since it is an insignificant block, code representing the insignificant block is outputted as the coded data 155 to the transmission buffer 6. If the coefficient number i is N^2 or less and Q(i) is not the last quantized level, 1 is added to the coefficient number i (step ST61), and the operation and quantization of next two-dimensional transform coefficient F(i) are performed continuously.

According to this embodiment, since all two-dimensional transform coefficients are not always necessary, at the one-dimensional linear transform operation of the first time, only the one-dimensional transform coefficients necessary to estimate the two-dimensional transform coefficients are estimated, thereby the number of the operation to obtain the transform coefficients can be reduced and further effects can be obtained.

Claims

1. A transform coding apparatus wherein a linear transform operation is performed on an input signal series, and transform coefficients are quantized and coded in sequence from the lower frequency components to the higher frequency components in the transform region, said transform coding apparatus comprising:
partitioning means (1) for partitioning said input signal series (101) into signal blocks;
linear transform means (2; 21) for performing a linear transform operation on the signal blocks (102) and for obtaining a series of transform coefficients (104; 121) in sequence from the lower frequency components to the higher frequency components;
quantization means (4; 31) for quantizing in sequence each of said transform coefficients (104; 121) in said series of transform coefficients (104; 121) outputted from said linear transform means (2; 21) counting means (22) for counting the number of consecutive zero quantized levels in the quantized transform coefficients (120; 131) quantized by said quantization means (4; 31) and for outputting the count values (122; 136) thereof;
threshold determining means (25; 32) for determining the threshold value (123; 137) of the number of consecutive zero quantized levels to be transmitted;
zero quantized level output means (24) for outputting zero quantized levels (126) when activated;
coding means (5; 43) for coding the outputs (120; 131) of said quantization means (4; 31);
a transmission buffer (6) for storing codes (128; 132) outputted by said coding means (5; 43); and
control means (7; 14) for determining the size of the quantization step used by said quantization means (4; 31) based on the buffer occupancy of said transmission buffer (6);
characterized by
decision means (23; 33) for obtaining one additional transform coefficient from said linear transform means (2; 21) when and only when the count value (122; 136) of consecutive zero quantized levels is less than the threshold value (123; 137), and for activating said zero quantized level output means (24) for subsequent transform coefficients when said count value (122; 136) equals said threshold value (123; 137); and
said threshold determining means (25; 32) determining said threshold value (123; 137) based on the buffer occupancy of said transmission buffer (6).

2. A transform coding apparatus as set forth in claim 1, wherein said threshold determining means (25; 32)

* C L M S *

tization step size 135, and outputs the quantized level Q(i) 153 (step ST54). Next, decision is performed regarding whether the quantized level Q(i) is zero or not (step ST55). If the value of Q(i) is not zero, the event storage section 42 stores set comprising the count value 136 of the counter 22 and Q(i) being non-zero quantized level as an event. In this case, the counter 22 makes the count value 22 zero (step ST56). On the other hand, if the quantization coefficient Q(i) is zero in the step ST55, the counter 22 adds 1 to the count value 136 (step ST57). The decision section 33 compares the count value 136 with the threshold value 137 (step ST58), and outputs the decision result 138. If the decision result 138 indicates that the count value 136 is equal to or more than the threshold value 137, the one-dimensional linear transform section 51 and the quantization section 41 stop the processing (step ST59). Set of the number of the zero coefficients among the quantized levels and the value of the non-zero quantized levels stored in the event storage section 42 is outputted to the code allocation section 43 (step ST62). In the comparison of the count value 136 with the threshold value 137 in the decision section 33 as above described, if the count value 136 is less than the threshold value 137 or if the processing in the step ST56 terminates, the event storage section 42 performs decision whether the coefficient number i becomes N^2 or not (step ST60). If the coefficient number i is N^2, i.e., Q(i) is the last quantized level, the event storage section 42 outputs the event 154 stored at present (step ST62), and the processing of the pixel block ends. The code allocation section 43 allocates Huffman codes and adds EOB to the outputted event 154, and outputs the coded data 155 to the transmission buffer 6. On the contrary, if there is no event 155 to be outputted, since it is an insignificant block, code representing the insignificant block is outputted as the coded data 155 to the transmission buffer 6. If the coefficient number i is N^2 or less and Q(i) is not the last quantized level, 1 is added to the coefficient number i (step ST61), and the operation and quantization of next two-dimensional transform coefficient F(i) are performed continuously.

According to this embodiment, since all two-dimensional transform coefficients are not always necessary, at the one-dimensional linear transform operation of the first time, only the one-dimensional transform coefficients necessary to estimate the two-dimensional transform coefficients are estimated, thereby the number of the operation to obtain the transform coefficients can be reduced and further effects can be obtained.

Claims

1. A transform coding apparatus wherein a linear transform operation is performed on an input signal series, and transform coefficients are quantized and coded in sequence from the lower frequency components to the higher frequency components in the transform region, said transform coding apparatus comprising:
partitioning means (1) for partitioning said input signal series (101) into signal blocks;
linear transform means (2; 21) for performing a linear transform operation on the signal blocks (102) and for obtaining a series of transform coefficients (104; 121) in sequence from the lower frequency components to the higher frequency components;
quantization means (4; 31) for quantizing in sequence each of said transform coefficients (104; 121) in said series of transform coefficients (104; 121) outputted from said linear transform means (2; 21) counting means (22) for counting the number of consecutive zero quantized levels in the quantized transform coefficients (120; 131) quantized by said quantization means (4; 31) and for outputting the count values (122; 136) thereof;
threshold determining means (25; 32) for determining the threshold value (123; 137) of the number of consecutive zero quantized levels to be transmitted;
zero quantized level output means (24) for outputting zero quantized levels (126) when activated;
coding means (5; 43) for coding the outputs (120; 131) of said quantization means (4; 31);
a transmission buffer (6) for storing codes (128; 132) outputted by said coding means (5; 43); and
control means (7; 14) for determining the size of the quantization step used by said quantization means (4; 31) based on the buffer occupancy of said transmission buffer (6);
characterized by
decision means (23; 33) for obtaining one additional transform coefficient from said linear transform means (2; 21) when and only when the count value (122; 136) of consecutive zero quantized levels is less than the threshold value (123; 137), and for activating said zero quantized level output means (24) for subsequent transform coefficients when said count value (122; 136) equals said threshold value (123; 137); and
said threshold determining means (25; 32) determining said threshold value (123; 137) based on the buffer occupancy of said transmission buffer (6).

2. A transform coding apparatus as set forth in claim 1, wherein said threshold determining means (25; 32)

* C L M S *

outputs the threshold value determined previously.

3. A transform coding apparatus as set forth in claim 1, wherein said threshold determining means (25; 32) decreases said threshold value (123; 137) when the buffer occupancy of said transmission buffer (6) is at a low value.

4. A transform coding apparatus as set forth in claim 1, characterized by
scan transform means (3) for rearranging the transform coefficients (103) outputted from said linear transform means (2) in sequence from the lower frequency components to the higher frequency components; and
event storage means for storing as events of the block the value of quantized transform coefficients which are non-zero quantized levels and the number of consecutive zero quantized levels counted by said counting means (22) before said non-zero quantized levels appear;
said coding means (5; 43) allocating codes to each event stored in said event storage means; and
said decision means quantizing one additional transform coefficient in said quantizing means when said count value of consecutive zero quantized levels counted by said counting means is less than said threshold value and terminating the quantization of subsequent transform coefficients when said count value equals said threshold value.

5. A transform coding apparatus wherein a two-dimensional linear transform operation is performed on an input signal series, and transform coefficients are quantized and coded in sequence from lower frequency components to higher frequency components in the transform region, said transform coding apparatus comprising: partitioning means (1) for partitioning said input signal series (101) into input signal blocks (102);
first transform means (50) for applying a one-dimensional linear transform operation to the partitioned input signal blocks (102) so as to obtain a one-dimensional transform coefficient block (151);
second transform means (51) for further applying an orthogonal one-dimensional linear transform operation to the one-dimensional transform coefficient block (151) so as to obtain a series of two-dimensional cofficients (152) in sequence from the lower frequency components to the higher frequency components;
quantizing means (41) for quantizing each two-dimensional transform coefficient (152) outputted from said second transform means (51);
counting means (22) for counting the number of consecutive zero quantized levels in the values of the quantized transform coefficients quantized by said quantizing means and for outputting the count values thereof;
threshold determining means (32) for determining the threshold of the number of consecutive zero quantized levels to be transmitted;
event storage means (42) for storing as events of the block the value of quantized transform coefficients which are non-zero quantized levels and the number of consecutive zero quantized levels (136) counted by said counting means (22) before the non-zero quantized levels appear;
coding means (43) for allocating codes to each event stored in said event storage means (42);
a transmission buffer (6) for storing codes outputted by said coding means (43); and
control means (7) for determining size of quantization step used by said quantization means (41) based on the buffer occupancy of said transmission buffer (6);
characterized by
decision means (33) for obtaining one further two-dimensional transform coefficient from said second transform means when said value of consecutive zero quantized levels is less than said threshold value and for terminating the second transform and quantizing process for subsequent two-dimensional transform coefficients when said count value equals said threshold value; and
said threshold determining means (32) determining said threshold value based on the buffer occupancy of said transmission buffer (6).

6. A transform coding apparatus as set forth in claim 5, wherein said threshold determining means (32) decreases said threshold value when the buffer occupancy of said transmission buffer (6) is at a low value.

Patentansprüche

1. Transformationscodierungsgerät, in welchem eine lineare Transformation einer Eingangssignalfolge aus-

* C L M S *

geführt wird und Transformationskoeffizienten in einer Folge von den Komponenten niedrigerer Frequenz zu den Komponenten höherer Frequenz im Transformationsbereich quantisiert und codiert werden, mit:
einer Aufteilungseinrichtung (1) zum Aufteilen der Eingangssignalfolge (101) in Signalblöcke;
einer Lineartransformationseinrichtung (2; 21) zum Ausführen einer linearen Transformation der Signalblöcke (102) und zum Erhalten einer Reihe von Transformationskoeffizienten (104; 121) in einer Folge von Komponenten niedrigerer Frequenz zu den Komponenten höherer Frequenz;
einer Quantisierungseinrichtung (4; 31) zum Quantisieren der Transformationskoeffizienten (104; 121) in der Reihe der von der Lineartransformationseinrichtung (2; 21) ausgegebenen Transformationskoeffizienten in einer Folge;
einer Zähleinrichtung (22) zum Zählen der Anzahl der aufeinanderfolgenden, nullquantifizierten Pegel der durch die Quantisierungseinrichtung (4; 31) quantisierten Transformationskoeffizienten (120; 131) und zum Ausgeben der Zählwerte (122; 135);
einer Schwellwertbestimmungseinrichtung (25; 32) zum Bestimmen des Schwellwertes (123; 137) der Anzahl zu übertragender, aufeinanderfolgender nullquantisierter Pegel;
einer Ausgabeeinrichtung (24) für nullquantisierte Pegel zum Ausgeben nullquantisierter Pegel (126) bei Aktivierung;
einer Codierungseinrichtung (5; 43) zum Codieren der Ausgangssignale (120; 131) der Quantisierungseinrichtung (4; 31);
einem Übertragungspuffer (6) zum Speichern der durch die Codierungseinrichtung (5; 43) ausgegebenen Codierungen (128; 132); und
einer Steuereinrichtung (7; 14) zum Bestimmen der Größe der durch die Quantisierungseinrichtung (4; 31) verwendeten Quantisierungsschritte, basierend auf der Pufferbelegung des Übertragungspuffers (6);
gekennzeichnet durch
eine Entscheidungseinrichtung (23; 33) zum Erhalten eines zusätzlichen Transformationskoeffizienten von der Lineartransformationseinrichtung (2; 21), wenn und nur wenn der Zählwert (122; 136) der aufeinanderfolgenden, nullquantifizierten Pegel kleiner als der Schwellwert (123; 137) ist, und zum Aktivieren der Ausgabeeinrichtung (24) für nullquantifizierte Pegel für nachfolgende Transformationskoeffizienten, wenn der Zählwert (122; 136) gleich dem Schwellwert (123; 137) ist; wobei
die Schwellwertbestimmungseinrichtung (25; 32) den Schwellwert (123; 137) auf der Basis der Pufferbelegung des Übertragungspuffers (6) bestimmt.

2. Transformationscodierungsgerät nach Anspruch 1, bei dem die Schwellwertbestimmungseinrichtung (25; 32) den vorher bestimmten Schwellwert ausgibt.

3. Transformationscodierungsgerät nach Anspruch 1, bei dem die Schwellwertbestimmungseinrichtung (25; 32) den Schwellwert (123; 137) herabsetzt, wenn die Pufferbelegung des Übertragungspuffers (6) auf einem niedrigen Wert liegt.

4. Tranformationscodierungsgerät nach Anspruch 1,
gekennzeichnet durch
eine Abtastübertragungseinrichtung (3) zum Neuanordnen der von der Lineartransformationseinrichtung (2) ausgegebenen Transformationskoeffizienten (103) in einer Folge von Komponenten mit niedrigerer Frequenz zu Komponenten mit höherer Frequenz; und
eine Ereignisspeichereinrichtung zum Speichern der Werte der quantifizierten Transformationskoeffizienten, welche einen nicht-nullquantifizierten Pegel aufweisen, und der durch die Zähleinrichtung (22) gezählten Anzahl von aufeinanderfolgenden nullquantifizierten Pegeln als Ereignisse des Blocks, bevor die nicht-nullquantifizierten Pegel auftreten;
wobei die Codiereinrichtung (5; 73) jedem in der Ereignisspeichereinrichtung gespeicherten Ereignis Codes zuweist; und
die Entscheidungseinrichtung einen zusätzlichen Transformationskoeffizienten in der Quantifizierungseinrichtung quantifiziert, wenn der Zählwert der durch die Zähleinrichtung gezählten aufeinanderfolgenden, nullquantifizierten Pegel geringer als der Schwellwert ist und die Quantifizierung nachfolgender Transformationskoeffizienten beendet, wenn der Zählwert gleich dem Schwellwert ist.

5. Tranformationscodierungsgerät, bei dem eine zweidimensionale Lineartransformation mit einer Eingangssignalreihe ausgeführt wird und Transformationskoeffizienten in einer Folge von Komponenten niedrigerer Frequenz zu Komponenten höherer Frequenz im Transformationsbereich quantifiziert und codiert werden, mit:

einer Aufteilungseinrichtung (1) zum Aufteilen der Eingangssignalfolgen (101) in Eingangssignalblöcke (102);
einer ersten Transformationseinrichtung (50) zum Anwenden einer eindimensionalen, linearen Transformation auf die aufgeteilten Eingangssignalblöcke (102), um einen eindimensionalen Transformationskoeffizientenblock (151) zu erhalten;
einer zweiten Transformationseinrichtung (51) zur weiteren Anwendung einer orthogonalen, eindimensionalen linearen Transformation auf den eindimensionalen Transformationskoeffizientenblock (151), um eine Reihe zweidimensionaler Koeffizienten (152) in einer Folge von Komponenten mit niedrigerer Frequenz zu Komponenten mit höherer Frequenz zu erhalten;
einer Quantifizierungseinrichtung (41) zum Quantifizieren jedes von der zweiten Transformationseinrichtung (51) ausgegebenen, zweidimensionalen Transformationskoeffizienten (152);
einer Zähleinrichtung (22) zum Zählen der Anzahl der aufeinanderfolgenden, nullquantifizierten Pegel in den Werten der durch die Quantifizierungseinrichtung quantifizierten Transformationskoeffizienten und zum Ausgeben der Zählwerte;
einer Schwellwertbestimmungseinrichtung (32) zum Bestimmen des Schwellwertes der Anzahl der zu übertragenden aufeinanderfolgenden nullquantifizierten Pegel;
einer Ereignisspeichereinrichtung (42) zum Speichern der Werte der quantisierten Transformationskoeffizienten mit nicht-nullquantifizierten Pegeln und der durch die Zähleinrichtung (22) gezählte Anzahl der nullquantifizierten Pegel (136), bevor die nicht-nullquantifizierten Pegel auftreten, als Ereignisse des Blocks;
einer Codierungseinrichtung (43), um jedem in der Ereignisspeichereinrichtung (42) gespeicherten Ereignis Codes zuzuweisen;
einem Übertragungspuffer (6) zum Speichern von durch die Codierungseinrichtung (43) ausgegebenen Codes; und
einer Steuereinrichtung (7) zum Bestimmen der Größe der von der Quantisierungseinrichtung (41) verwendeten Quantifizierungsschritte, basierend auf der Pufferbelegung des Übertragungspuffers (6);
gekennzeichnet durch
eine Entscheidungseinrichtung (33) zum Erhalten eines weiteren zweidimensionalen Transformationskoeffizienten von der zweiten Transformationseinrichtung, wenn der Wert der aufeinanderfolgenden nullquantifizierten Pegel geringer als der Schwellwert ist, und zum Beenden der zweiten Transformation und des Quantifizierungsvorganges für nachfolgende, zweidimensionale Transformationskoeffizienten, wenn der Zählwert gleich dem Schwellwert ist; wobei
die Schwellwertbestimmungseinrichtung (32) den Schwellwert, basierend auf der Pufferbelegung des Übertragungspuffers (6), bestimmt.

6. Transformationscodierungsgerät nach Anspruch 5, bei dem die Schwellwertbestimmungseinrichtung (32) den Schwellwert herabsetzt, wenn die Pufferbelegung des Übertragungspuffers (6) auf einem niedrigen Wert liegt.

Revendications

1. Appareil de codage par transformation dans lequel une opération de transformation linéaire est effectuée sur une série de signaux d'entrée, et des coefficients de transformation sont quantifiés et codés en séquence, à partir des composantes basse fréquence jusqu'aux composantes haute fréquence de la région de transformation, ledit appareil de codage par transformation comprenant:

des moyens de division (1) pour diviser ladite série de signaux d'entrée (101) en blocs de signaux;

des moyens de transformation linéaire (2; 21) pour effectuer une opération de transformation linéaire sur les blocs de signaux (102) et pour obtenir une série de coefficients de transformation (104; 121) en séquence, à partir des composantes basse fréquence jusqu'aux composantes haute fréquence;

des moyens de quantification (4; 31) pour quantifier en séquence chacun desdits coefficients de transformation (104; 121) de ladite série de coefficients de transformation (104; 121) délivrée en sortie par lesdits moyens de transformation linéaire (2; 21);

des moyens de comptage (22) pour compter le nombre de niveaux quantifiés nuls consécutifs dans les coefficients de transformation quantifiés (120; 131) par lesdits moyens de quantification (4; 31) et pour délivrer en sortie leurs valeurs de comptage (122; 136);

des moyens de détermination de seuil (25; 32) pour déterminer la valeur de seuil (123; 137) du nombre de niveaux quantifiés nuls consécutifs à transmettre;

* C L M S *

des moyens de délivrance de niveaux quantifiés nuls (24) pour délivrer en sortie des niveaux quantifiés nuls (126), lorsqu'ils sont activés;

des moyens de codage (5; 43) pour coder les sorties (120; 131) desdits moyens de quantification (4; 31);

un tampon de transmission (6) pour emmagasiner des codes (128; 132) délivrés en sortie par lesdits moyens de codage (5; 43); et

des moyens de commande (7; 14) pour déterminer la grandeur du pas de quantification utilisé par lesdits moyens de quantification (4; 31) sur la base de l'encombrement dudit tampon de transmission (6);

caractérisé par

des moyens de décision (23; 33) pour obtenir un coefficient de transformation supplémentaire à partir desdits moyens de transformation linéaire (2; 21) lorsque, et uniquement lorsque, la valeur de comptage (122; 136) des niveaux quantifiés nuls consécutifs est inférieure à la valeur de seuil (123; 137), et pour activer lesdits moyens de délivrance de niveaux quantifiés nuls (24) pour des coefficients de transformation subséquents lorsque ladite valeur de comptage (122; 136) est égale à ladite valeur de seuil (123; 137); et par le fait que

lesdits moyens de détermination de seuil (25; 32) déterminent ladite valeur de seuil (123; 137) sur la base de l'encombrement dudit tampon de transmission (6).

2. Appareil de codage par transformation selon la revendication 1, dans lequel lesdits moyens de détermination de seuil (25; 32) délivrent en sortie la valeur de seuil déterminée auparavant.

3. Appareil de codage par transformation selon la revendication 1, dans lequel lesdits moyens de détermination de seuil (25; 32) diminuent ladite valeur de seuil (123; 137) lorsque l'encombrement dudit tampon de transmission (6) est faible.

4. Appareil de codage par transformation selon la revendication 1, caractérisé par

des moyens de transformation par balayage (3) servant à disposer dans un nouvel ordre les coefficients de transformation (103) délivrés en sortie par lesdits moyens de transformation linéaire (2) en séquence, depuis les composantes basse fréquence vers les composantes haute fréquence; et

des moyens d'emmagasinage d'événements pour emmagasiner, en tant qu'événements du bloc, la valeur des coefficients de transformation quantifiés qui sont des niveaux quantifiés non nuls et le nombre de niveaux quantifiés nuls consécutifs compté par lesdits moyens de comptage (22) avant que lesdits niveaux quantifiés non nuls n'apparaissent; et par le fait que

lesdits moyens de codage (5; 43) attribuent des codes à chaque événement emmagasiné dans lesdits moyens d'emmagasinage d'événements; et que

lesdits moyens de décision quantifient un coefficient de transformation supplémentaire dans lesdits moyens de quantification lorsque ladite valeur de comptage de niveaux quantifiés nuls consécutifs comptée par lesdits moyens de comptage est inférieure à ladite valeur de seuil et mettent fin à la quantification de coefficients de transformation subséquents lorsque ladite valeur de comptage est égale à ladite valeur de seuil.

5. Appareil de codage par transformation dans lequel une opération de transformation linéaire bi-dimensionnelle est effectuée sur une série de signaux d'entrée, et des coefficients de transformation sont quantifiés et codés en séquence depuis les composantes basse fréquence vers les composantes haute fréquence de la région de transformation, ledit appareil de codage par transformation comprenant:

des moyens de division (1) pour diviser ladite série de signaux d'entrée (101) en blocs de signaux d'entrée (102);

des premiers moyens de transformation (50) pour effectuer une opération de transformation linéaire unidimensionnelle sur les blocs de signaux d'entrée divisés (102) de façon à obtenir un bloc de coefficients de transformation uni-dimensionnels (151);

de seconds moyens de transformation (51) pour effectuer une autre opération de transformation linéaire unidimensionnelle orthogonale sur le bloc de coefficients de transformation uni-dimensionnels (151) de façon à obtenir une série de coefficients bi-dimensionnels (152) en séquence, en allant des composantes basse fréquence vers les composantes haute fréquence;

des moyens de quantification (41) pour quantifier chaque coefficient de transformation bi-dimensionnel (152) délivré en sortie par lesdits seconds moyens de transformation (51);

des moyens de comptage (22) pour compter le nombre de niveaux quantifiés nuls consécutifs dans les valeurs des coefficients de transformation quantifiés par lesdits moyens de quantification et pour dé-

* C L M S *

livrer en sortie leurs valeurs de comptage;

des moyens de détermination de seuil (32) pour déterminer le seuil du nombre de niveaux quantifiés nuls consécutifs à transmettre;

des moyens d'emmagasinage d'événements (42) pour emmagasiner, en tant qu'événements du bloc, la valeur des coefficients de transformation quantifiés qui sont des niveaux quantifiés non nuls et le nombre de niveaux quantifiés nuls consécutifs (136), compté par lesdits moyens de comptage (22), avant l'apparition des niveaux quantifiés non nuls;

des moyens de codage (43) pour attribuer des codes à chaque événement emmagasiné dans lesdits moyens d'emmagasinage d'événements (42);

un tampon de transmission (6) pour emmagasiner des codes délivrés en sortie par lesdits moyens de codage (43); et

des moyens de commande (7) pour déterminer la grandeur du pas de quantification utilisé par lesdits moyens de quantification (41) sur la base de l'encombrement dudit tampon de transmission (6);

caractérisé par

des moyens de décision (33) pour obtenir un autre coefficient de transformation bi-dimensionnel à partir desdits seconds moyens de transformation lorsque ladite valeur des niveaux quantifiés nuls consécutifs est inférieure à ladite valeur de seuil et pour mettre fin au second processus de transformation et de quantification concernant des coefficients de transformation bi-dimensionnels subséquents lorsque ladite valeur de comptage est égale à ladite valeur de seuil; et en ce que

lesdits moyens de détermination de seuil (32) déterminent ladite valeur de seuil sur la base de l'encombrement dudit tampon de transmission (6).

6. Appareil de codage par transformation selon la revendication 5, dans lequel lesdits moyens de détermination de seuil (32) diminuent ladite valeur de seuil lorsque l'encombrement dudit tampon de transmission (6) est faible.