

Description

The present invention relates to signal coding, and particularly to a method of coding an image composed of a plurality of picture elements forming one or more blocks of picture elements comprising, for each block, supplying representations of those picture elements in a selected sequence to an output wherein some of the representations are the differences between values of the relevant element and a prediction based on the value of at least the immediately preceding element in the said sequence.

Such a coding scheme is disclosed in US patent US-A-4,542,411 which describes a linear predictive coding method. It is there assumed that the tone levels of four picture elements are x_0 , x_1 , x_2 and x_3 , respectively. A predictive value of $\hat{x}_0$ of an objective picture element X_0 is provided by a linear predictive function of a particular type described in the referenced patent.

It goes on to state that in this linear predictive coding method, a difference value (referred to as a predictive error) between the predictive value $\hat{x}_0$ of the objective picture element (calculated using the there described predictive function) and an actual value x_0 of the objective picture element is evaluated and the evaluated difference value is coded and transmitted.

WO-A-8 702 854 discloses a hybrid coding process by transformation for the transmission of images or pictures. The pictures are defined by a sequence of frames, each frame containing a set of matrix-organised blocks, each block containing a set of digital data organised in matrix form and representing part of the picture. The process successively comprises the stage of transforming each block in the frequency range, quantifying the transformed coefficient of each block, evaluating the data volume necessary for coding said transformed block by intraframe mode statistical coding, evaluation a the data volume necessary for coding said transformed block by an interframe mode statistical coding, comparison of said data volumes and decision concerning the coding mode as a function of said data volumes and the maximum volume authorised by the flow rate and the transmission line and statistical coding of said block by a variable length code.

EP patent application EP-A-239, 076 discloses an encoder responsive to a sequence of coefficient blocks each of which is composed of a plurality of orthogonal transform coefficients subjected to predictive encoding and orthogonal transform, the coefficient blocks are classified by a classification circuit into a plurality of classes to produce a control signal representative of the classes. A quantisation unit, a code conversion unit and a coefficient selection unit are controlled by the control signal to select quantisation characteristics, code conversion characteristics and coefficient selection characteristics. The coefficient selection unit comprises a plurality of selection tables corresponding to the coefficient selection characteristics. Consequently the coefficients are adaptively encoded into a reduced amount of encoded codes on encoding a moving image.

US patent US-A-4,667,233 discloses apparatus for coding a video signal utilizing movement detection by comparing successive frames.

According to one aspect of the present invention a method of coding an image according to the preamble of Claim 1 is characterised in that the method includes the step of selecting as the selected sequence that one of a plurality of possible sequences of the picture elements within the block which has the highest correlation between successive elements in the sequence.

Normally the representations will be transmitted in an order which corresponds to the selected sequence, though this is not in principle essential.

The choice of sequence may be made by evaluating different sequences, but in some circumstances it may be possible to infer an appropriate choice from earlier coding steps.

The invention also extends, in a second aspect, to an apparatus for coding an image composed of a plurality of picture elements forming one or more blocks of picture elements comprising means for supplying representations of the picture elements of each block, in sequence to an output wherein some of the representations are the differences between values of the relevant element and a prediction based on the value of at least the immediately preceding element in the said sequence characterised in that the apparatus includes: selection means for selecting as the selected sequence that one of a plurality of possible sequences of the picture elements within the block which has the highest correlation between successive elements in the sequence.

Some embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a block diagram of one possible form of coder according to the invention;

Figure 2 illustrates a movement matrix;

Figures 3a-3h illustrates some vector quantisation (VQ) shapes;

Figures 4, 5 and 6 illustrate possible scan paths;

Figure 7 illustrates a possible sub-sampling format; and

Figure 8 is a block diagram of a coding unit;

Figure 9 is a block diagram of a change of movement detector which may be used in the apparatus of Figure 1; and

5 Figure 10 is a block diagram of a decoder for use with the apparatus of Figure 1.

Figure 1 shows a conditional replenishment video coder, where video signals (assumed to be in digital form) are supplied to an input 1. The current frame of a picture is compared in a change or movement detector 2 with the output of a local decoder 9. The local decoder produces a "previous frame" output which is the same as that produced by a remote decoder; the object of the comparison is to identify those
10 parts of the picture which have changed so that only information concerning those parts needs to be sent to the decoders, to update a stored representation of the frame.

The signals are processed on a block-by-block basis - an 8 x 8 block is assumed - and the change detector 2 therefore produces an 8 x 8 bit map. A typical map is shown in figure 2, where the elements of the block corresponding to picture elements, (pixels) which have changed are shown shaded.

15 In practice, transmission of information concerning only the changed elements involves a significant addressing overhead and therefore it is preferred to match the bit map to one of a limited number - typically 128 - of standard shapes (a few are illustrated in figures 3a-3h). Since it is preferable to transmit information for an unchanged pixel than to fail to transmit information for a changed pixel, the shape chosen is the smallest (i.e. with the least number of shaded elements) which has a shaded area covering the shaded
20 elements of the bit map.

This process is termed vector quantisation (VQ) and is indicated as vector quantiser 4 in figure 1. One transmits, for the block, a VQ number identifying the chosen shape, along with information concerning pixels deemed - in accordance with the chosen shape - to have changed. The output data are combined and buffered in a buffer 5 prior to passage to an output 6. As is conventional in such systems, the buffer is
25 used to smooth variations in the rate at which data are generated (due to the picture content dependent coding) and interface to a regular transmitted rate) and the buffer fullness state used to control the rate of generation (eg. by varying the change detector thresholds (control line 7).

Inter-element differential coding is used for coding the pixels. The object of differential coding is to take advantage of the correlation between successive elements to reduce the amount of data which need to be
30 transmitted. In this coder, variation of the sequence of transmission of the pixels is permitted, the object being to choose that one of a plurality of allowed sequences which maximises the inter element correlation - it being understood that the differential coding uses the immediately preceding element in the sequence as predictor (though the use of other elements as well is not ruled out). The decoder must of course be informed, by some means, which sequence has been chosen.

35 It should be noted that it is not actually necessary (although it is certainly convenient) that the order in which the data are transmitted corresponds to the chosen sequence. What is important is that the prediction used for the differential coding is, or at least involves, the preceding element in the chosen sequence.

In principle one could examine different possible sequences and assess which has the highest correlation (e.g. by computing the sum of the squares of the differential values). However where, as in this
40 example, vector quantisation is employed, it is possible to infer the sequence from the VQ shape - this reduces computation and the VQ number can indicate the sequence to the decoder.

For example, consider the shape shown in figure 3(g). All the "changed" pixels are at the left-hand edge of the block, and therefore there is a high probability that these correspond to a vertical edge moving horizontally in the image. We deduce that taking the pixels in vertical sweeps, for example as illustrated in
45 figure 4, will give a better inter-pixel correlation than a horizontal scan, and therefore this sequence is chosen for the differential coding.

For blocks (eg. fig 3b) having no particular orientation, or blocks having large numbers of changed pixels it may be preferable to adopt a different coding strategy. An example of a coding scheme (carried out by unit 8 of fig 1) will now be described in more detail.

50 1. For small VQ shapes, typically those containing less than 24 pixels (the maximum for an 8x8 block is of course 64):-

The actual value of the first pixel in the VQ shape is first transmitted. The values of the subsequent pixels in the VQ shape are transmitted in the form of an error signal using the quantised prediction error between the previous transmitted element in the VQ shape and the current element.

55 These quantised values are coded and transmitted. The number of values transmitted for small VQ shapes is implicit in the VQ number since all pixels in the VQ shape are transmitted. The order in which the pixels are transmitted is also implied by the VQ number. Shapes with vertical orientation are transmitted in the order shown in figure 4. VQ shapes with horizontal orientation are transmitted in the

order shown in figure 5, whilst a VQ shape with no particular orientation is transmitted in spiral format as shown in figure 6. Variable length coding may be used in known manner for the transmitted values.

2. For larger VQ shapes, typically those containing more than 24 "changed" pixels, a sequence selection is made (though for a different reason from that outlined above). That scanning order (of a limited number of permitted sequences) is chosen which has the least number of non-"changed" pixels between the first and last "changed" pixels, and leading and trailing unchanged pixels are not transmitted. The transmitted information in this case is the VQ code, a Scan Class code identifying the sequence, the address of the first pixel to be transmitted, the number of pixels to be transmitted, and the actual pixel data (transmitted, as before, as one absolute value followed by differential values).

3. Optionally (though not illustrated in the Figures), certain large VQ shapes may be element subsampled to further reduce the data rate during large motion. Subsampling may be performed on a fixed quincunx format as illustrated in figure 7 and its use is implied to the decoder by the use of certain VQ numbers. The class code, the address of the first pixel to be transmitted and the number of pixels to be transmitted are sent, as before.

Only the elements which are on the quincunx grid and fall between the start of the scan (given by ABSXY) and the last element in the scan are subsampled. The decoder uses the surrounding transmitted elements to interpolate the values of the subsample pixels. The following rules are used: The maximum and minimum values of pixels A,B,C and D are found and discarded. The value inserted for the subsampled value is simply the average of the remaining two pixels.

A typical coding format is as follows: -

PH Picture Data PH Picture Data PH etc...

PH is the Picture Header which has the following structure:

PSC BS TR

PSC is the Picture Start Code which is a 21 bit unique word

0000 0000 0000 0001 0000 0

BS is the encoder buffer state sampled at the time of the top of the picture and represented with 6 bits, MSB first.

TR is the picture's temporal reference; simply a 3bit number (MSB first) representing the sequence of the PH in modulo-8 form.

The picture is considered to be divided into Groups of Blocks (GOB), each of which consists of 44 luminance blocks one line of 22 chrominance (R-Y) blocks and one line of 22 chrominance (B-Y) blocks.

Picture Data is structured in the following way

GBSC GN GOB data

GBSC is the Group of block Start Code which is a 16 bit word:

0000 0000 0000 0001

GN is the group number. This is a 5 bit number signifying the vertical spatial position, in units of groups, of the current group of blocks. GN is transmitted MSB first and has the range 1 at the top of the picture and 18 at the bottom. All 18 GBSC along with their corresponding GN will be transmitted.

GOB data has the following structure:

BA PCM VQ Scan ABSXY TOTVLC VLC, VLC, etc BA PCM VQ Scan

Class

Optional Fields

Class

etc, etc.....

BA - is the block address within a GOB. It is a variable length code word and gives the run length of the non-transmitted blocks between this block and the previous transmitted block. In the case of the first transmitted block in a GOB, BA gives the absolute address.

PCM - this is the PCM value of the first pixel coded within the VQ shape. This serves to prevent error extension between blocks.

VQ - is a 6 bit word representing the VQ number for the moving area.

Scan Class - This is a 2 bit optional field which occurs for certain VQ numbers (i.e. certain VQ numbers imply its presence). Its purpose is to allow the pixel scan path to be indicated for larger VQ shapes.

ABSXY - is a 6 bit optional field giving the address of the first changed pixel within the VQ shape. This is only used on the larger VQ shapes and its existence is implied by the use of certain preceding VQ numbers.

5 TOTVLC - This is a 6 bit optional field which occurs for certain VQ numbers (ie certain VQ numbers imply its presence). It indicates the number of VLC codes present in the following VLC field.

VLC - is a variable length word giving the prediction error of the current element using the previous transmitted element as a predictor. The number of VLC values is determined by the number of pixels in the VQ shape or by the use of TOTVLC when present.

10 Note: The optional fields will either be all present or all absent dependent on the VQ number of a particular block.

The structure of the coding unit 8 is illustrated in Figure 9. The incoming pixel data are received by a resequencing store 81, where the data are stored in the order in which they arrive and the data determined by the VQ shape selected are read out under control of an address generator 82 in the order required for that shape. The data PCM for the first transmitted element pass directly via a line 83 directly to the output 15 83 of the unit; for subsequent elements the output is taken via a changeover switch 84 from a differential coder comprising a one-element delay 85 and subtractor 86.

For the larger VQ shapes - where, it will be recalled, the transmission sequence is still varied but differential coding not used - of course the switch 84 remains in its upper position bypassing the differential coder 85, 86. The change, or movement, detector 2 can in principle be any of those conventionally used. 20 However, a preferred version is shown in figure 9.

Block 10 is a **PROM** containing look-up tables to compare the previously coded picture (decoded by a local decoder 9) with the new incoming picture. The modulo of the pixel-by-pixel frame-to-frame difference (d) is subjected to the non-linear expression:

25

$$f(|a-b|) = [1 - e^{-(d/k)^g}]$$

30 where

k is a constant currently set to 10, and

g is a constant currently set to 0.9

This has the effect of reducing the small pixel frame differences (noise) while leaving the large frame differences unchanged. These modified frame differences are then truncated to four bits by forcing all 35 values greater than 15 to the value 15 and leaving values less than 15 unchanged (indicated as $f'(|a-b|)$ in figure 9). The look-up table in block 10 also generates a signal which indicates if the magnitude of the modified frame difference is greater than some threshold T (T is typically set to 5). This signal is fed forward to an **AND** gate 22.

The four bit modified frame difference is then passed through the transversal filter containing element 40 delays 11, 12, 13 and 14, multipliers (**PROM** look-ups) 15, 16, 17, 18 and 19 and an adder at block 20. The multiplier values alpha 1, 2, 3, 4 and 5 have typical values x4, x8, x12, x8, x4. The sum of the weighted modified frame differences is then compared with a threshold in a comparator 21. This threshold is varied according to the fullness of the coders channel buffer in a way which reduces the number of moving pixels as the coders channel buffer becomes full. We currently use the following formula: -

45

$$\text{Threshold } G(B) = 8[10 + (B)/3]$$

where the buffer state B is a number between 0 and 63 indicating the number of Kbits of data contained in the buffer.

50 Changed pixels are signalled on a pixel-by-pixel basis by the **AND** gate 22 if the sum of the weighted modified frame differences is greater than $G(B)$ AND the feed forward path threshold condition is met. The reason for including the feed forward path is because the transversal filter mechanism tends to spread the frame differences which has the effect of causing pixels adjacent to a large frame difference to exceed the threshold $G(B)$. A simple check to establish if the pixel had a significant frame difference before transversal 55 filtering limits changed pixel generation to only those points which have truly changed.

The vector quantiser 4 can again be a known device. One possibility is that described in our patent application no. EP-A-0 272 794.

Simpler but cruder, another option is to convert the 8x8 matrix to a 4x4 matrix by creating each 'new' element as an OR function of four 'old' elements; this reduces the number of elements in the matrix to a size (16) which can be used to address a look-up table - in the form of a 64 Kbyte read only memory in which the appropriate VQ numbers are stored.

5 Figure 10 is a block diagram of a decoder for use with the coder described above. The incoming data is first supplied to a buffer 30 which serves to buffer the rate at which data are received to the irregular rate at which they are processed. The data are demultiplexed by a demultiplexer 31 under control of a control unit 32 which recognises the start codes (PSC, GBSC). The variable length codes are decoded in a VLC decoder 33 and then pass via a differential decoder comprising an adder 34 and delay 35 to the data input
10 of a video frame store 36. The first absolute pixel value PCM is switched in to reset the delay line via a switch 37.

The block address BA and the code VQ and the VQ options if present are used by a write address generator 38 to compute, in accordance with the transmission sequence indicated by these variables, the pixel coordinate (and hence address in the store 36) of each element value supplied to the data input of the
15 store 36, so that these values are entered into the appropriate locations in the store 36 to update the 'received' picture. The picture element data are read out sequentially under control of a read address generator 39 to produce an output video signal.

This arrangement assumes a store 36 capable of random addressing for write purposes, so that effectively the original sequence of the data is restored by controlling the sequence of addresses from the generator 38. Alternatively, of course, the data could be 'shuffled' using a resequencing store such as the
20 store 81 (Figure 8) used in the coder.

The local decoder 9 shown in Figure 1 may have the same structure as that shown in Figure 10 - except that the buffer 30 and demultiplexing arrangements 31, 32 would not be required.

25 Claims

1. A method of coding an image composed of a plurality of picture elements forming one or more blocks of picture elements comprising, for each block, obtaining representations of those picture elements in a sequence from a differential coder (83-86) wherein some of the representations are the differences
30 between values of the relevant element and a prediction based on the value of at least the immediately preceding element in the said sequence characterised in that the method includes the steps of: selecting as a selected sequence that one of a plurality of possible sequences of the picture elements within the block which has the highest correlation between successive elements in the sequence, and supplying the picture elements in said selected sequence to said differential coder (83-86).
- 35 2. A method of coding an image as claimed in claim 1 in which the selection of the selected sequence is carried out by:
 - (i) comparing picture elements of the block with those of the corresponding block of a previously coded image to produce a matrix of values each value indicating whether the corresponding element is, in accordance with a predetermined criterion, deemed to have changed between the two blocks,
 - 40 (ii) selecting one of a predetermined set of standard matrices each of which identifies a region of picture elements of the block as being deemed to have changed by matching the matrix to the set of standard matrices there being a predetermined sequence of coding associated with each of the standard matrices;
 - 45 (iii) coding for output those elements within the identified region deemed to have changed, the sequence of coding of the elements being that associated with the selected matrix.
3. A method as claimed in claim 2, in which when the region associated with a selected one of the standard matrices is of a generally vertically extending elongate shape the coding sequence is defined
50 by a scan of the region in vertical sweeps and when the region is of a generally horizontally extending elongate shape the coding sequence is defined by a scan of the region in horizontal sweeps.
4. A method according to any one of claims 1, 2 and 3 in which the representations are output in the selected sequence.
- 55 5. An apparatus for coding an image (Fig 1) composed of a plurality of picture elements forming one or more blocks of picture elements comprising a differential coder (83-86) for providing representations of the picture elements, of each block, in a sequence wherein some of the representations are the



Simpler but cruder, another option is to convert the 8x8 matrix to a 4x4 matrix by creating each 'new' element as an OR function of four 'old' elements; this reduces the number of elements in the matrix to a size (16) which can be used to address a look-up table - in the form of a 64 Kbyte read only memory in which the appropriate VQ numbers are stored.

Figure 10 is a block diagram of a decoder for use with the coder described above. The incoming data is first supplied to a buffer 30 which serves to buffer the rate at which data are received to the irregular rate at which they are processed. The data are demultiplexed by a demultiplexer 31 under control of a control unit 32 which recognises the start codes (PSC, GBSC). The variable length codes are decoded in a VLC decoder 33 and then pass via a differential decoder comprising an adder 34 and delay 35 to the data input of a video frame store 36. The first absolute pixel value PCM is switched in to reset the delay line via a switch 37.

The block address BA and the code VQ and the VQ options if present are used by a write address generator 38 to compute, in accordance with the transmission sequence indicated by these variables, the pixel coordinate (and hence address in the store 36) of each element value supplied to the data input of the store 36, so that these values are entered into the appropriate locations in the store 36 to update the 'received' picture. The picture element data are read out sequentially under control of a read address generator 39 to produce an output video signal.

This arrangement assumes a store 36 capable of random addressing for write purposes, so that effectively the original sequence of the data is restored by controlling the sequence of addresses from the generator 38. Alternatively, of course, the data could be 'shuffled' using a resequencing store such as the store 81 (Figure 8) used in the coder.

The local decoder 9 shown in Figure 1 may have the same structure as that shown in Figure 10 - except that the buffer 30 and demultiplexing arrangements 31, 32 would not be required.

Claims

1. A method of coding an image composed of a plurality of picture elements forming one or more blocks of picture elements comprising, for each block, obtaining representations of those picture elements in a sequence from a differential coder (83-86) wherein some of the representations are the differences between values of the relevant element and a prediction based on the value of at least the immediately preceding element in the said sequence characterised in that the method includes the steps of: selecting as a selected sequence that one of a plurality of possible sequences of the picture elements within the block which has the highest correlation between successive elements in the sequence, and supplying the picture elements in said selected sequence to said differential coder (83-86).
2. A method of coding an image as claimed in claim 1 in which the selection of the selected sequence is carried out by:
 - (i) comparing picture elements of the block with those of the corresponding block of a previously coded image to produce a matrix of values each value indicating whether the corresponding element is, in accordance with a predetermined criterion, deemed to have changed between the two blocks,
 - (ii) selecting one of a predetermined set of standard matrices each of which identifies a region of picture elements of the block as being deemed to have changed by matching the matrix to the set of standard matrices there being a predetermined sequence of coding associated with each of the standard matrices;
 - (iii) coding for output those elements within the identified region deemed to have changed, the sequence of coding of the elements being that associated with the selected matrix.
3. A method as claimed in claim 2, in which when the region associated with a selected one of the standard matrices is of a generally vertically extending elongate shape the coding sequence is defined by a scan of the region in vertical sweeps and when the region is of a generally horizontally extending elongate shape the coding sequence is defined by a scan of the region in horizontal sweeps.
4. A method according to any one of claims 1, 2 and 3 in which the representations are output in the selected sequence.
5. An apparatus for coding an image (Fig 1) composed of a plurality of picture elements forming one or more blocks of picture elements comprising a differential coder (83-86) for providing representations of the picture elements, of each block, in a sequence wherein some of the representations are the



- differences between values of the relevant element and a prediction based on the value of at least the immediately preceding element in the said sequence characterised in that the apparatus includes: selection means (4,81,82) for selecting as a selected sequence that one of a plurality of possible sequences of the picture elements within the block which has the highest correlation between successive elements in the sequence, and is arranged to supply the picture elements in said selected sequence to said differential coder (83-86)
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6. An apparatus for coding an image as claimed in claim 5 in which the selection means (4,81,82) for selecting the selected sequence comprises:
- 10 (i) comparing means (2) for comparing picture elements of the block with those of the corresponding block of a previously coded image to produce a matrix of values each value indicating whether the corresponding element is, in accordance with a predetermined criterion, deemed to have changed between the two blocks,
- 15 (ii) means (4) for selecting one of a predetermined set of standard matrices each of which identifies a region of picture elements of the block as being deemed to have changed by matching the matrix to the set of standard matrices there being a predetermined sequence of coding associated with each of the standard matrices;
- 20 (iii) coding means (8) for coding for output those elements within the identified region deemed to have changed, the sequence of coding of the elements being that associated with the selected matrix.
7. Apparatus as claimed in claim 6, in which when the region associated with a selected one of the standard matrices is of a generally vertically extending elongate shape (f,g,h) the coding sequence is defined by a scan of the region in vertical sweeps (Fig 4) and when the region is of a generally horizontally extending elongate shape (b,c,d) the coding sequence is defined by a scan of the region in horizontal sweeps (Fig 5).
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8. Apparatus as claimed in any one of claims 5, 6 and 7 in which coding means (8) is arranged to output the representations in the the order of the selected sequence.
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9. An apparatus according to any one of claims 6, 7 and 8 in which the comparing means comprises:
- means (10) for forming a first change signal representative of the difference between each picture element of a current frame of the video signal and a previous frame of the signal;
- 35 filter means (11, 12,...,20) for forming a weighted sum of the first change signals formed in respect of a picture element under consideration and picture elements spatially adjacent thereto and comparing the sum with a threshold;
- means (21) for forming a second change signal representative of the difference between each picture element of a current frame of the video signal and a previous frame of the signal and comparing the second change signal with a threshold; and
- 40 means (22) arranged in operation to output a change indication for a picture element only if both thresholds are exceeded.
10. A decoder for decoding signals encoded using the method of of any one of claims 1, 2, 3 and 4 comprising:
- 45 means (34,35) for receiving differential values and computing the absolute values thereof; and
- resequencing means (36,38,39) responsive, in use, to received codes indicating the selected sequence to change the sequence of the absolute values.

Patentansprüche

- 50
1. Verfahren zum Codieren eines Bildes, das aus einer Vielzahl von Bildelementen, die einen oder mehrere Blöcke aus Bildelementen bilden, zusammengesetzt ist, wobei das Verfahren für jeden Block ein Erlangen von Darstellungen jener Bildelemente in einer Sequenz von einem Differentialcodierer (83-86) aufweist, wobei einige der Darstellungen die Unterschiede zwischen Werten des relevanten Elements und einer Vorhersage auf der Grundlage des Wertes von zumindest dem unmittelbar vorhergehenden Element in dieser Sequenz sind, dadurch gekennzeichnet, daß das Verfahren die Schritte aufweist:
- 55 Auswählen derjenigen Sequenz aus einer Vielzahl möglicher Sequenzen von Bildelementen innerhalb

des Blocks, die die höchste Korrelation zwischen aufeinanderfolgenden Elementen in der Sequenz hat, als eine ausgewählte Sequenz, und
Liefern der Bildelemente in der ausgewählten Sequenz an den Differentialcodierer (83-86).

- 5 2. Verfahren zum Codieren eines Bildes nach Anspruch 1, bei dem die Auswahl der ausgewählten Sequenz ausgeführt wird durch:
 - (i) Vergleichen von Bildelementen des Blocks mit jenen des entsprechenden Blocks eines vorher codierten Bildes, um eine Matrix aus Werten zu erzeugen, wobei jeder Wert anzeigt, ob von dem entsprechenden Element gemäß einem vorbestimmten Kriterium angenommen wird, daß es sich
10 zwischen zwei Blöcken geändert hat,
 - (ii) Auswählen einer Matrix aus einer vorbestimmten Menge von Standardmatrizen, von denen jede einen Bereich von Bildelementen des Blocks identifiziert, von denen angenommen wird, daß sie sich geändert haben, und zwar durch Abgleichen der Matrix mit der Menge von Standardmatrizen, wobei es eine vorbestimmte Codiersequenz gibt, die zu jeder der Standardmatrizen gehört;
 - 15 (iii) Codieren zur Ausgabe jener Elemente innerhalb des identifizierten Bereichs, von denen angenommen wird, daß sie sich geändert haben, wobei die Codiersequenz der Elemente jene ist, die zu der ausgewählten Matrix gehört.
- 20 3. Verfahren nach Anspruch 2, bei dem, wenn der Bereich, der zu einer ausgewählten Matrix von den Standardmatrizen gehört, von einer im allgemeinen vertikal sich erstreckenden verlängerten Gestalt ist, die Codiersequenz durch ein Abtasten des Bereichs in vertikalen Ablenkungen festgelegt ist und, wenn der Bereich von einer im allgemeinen horizontal sich erstreckenden verlängerten Gestalt ist, die Codiersequenz durch eine Abtastung des Bereichs in horizontalen Ablenkungen definiert ist.
- 25 4. Verfahren nach einem der Ansprüche 1, 2 oder 3, bei dem die Darstellungen in der gewählten Sequenz ausgegeben werden.
- 30 5. Vorrichtung zum Codieren eines Bildes (Fig. 1), das aus einer Vielzahl von Bildelementen, die einen oder mehrere Blöcke von Bildelementen bilden, zusammengesetzt ist, wobei die Vorrichtung einer Differentialcodierer (83-86) zum Bereitstellen von Darstellungen der Bildelemente eines jeden Blocks in einer Sequenz aufweist, wobei einige der Darstellungen die Unterschiede zwischen Werten des relevanten Elements und einer Vorhersage auf der Grundlage des Werts von zumindest dem unmittelbar vorhergehenden Element in der Sequenz sind, dadurch gekennzeichnet, daß die Vorrichtung aufweist:
35 eine Auswähleinrichtung (4, 81, 82) zum Auswählen derjenigen Sequenz aus einer Vielzahl möglicher Sequenzen von Bildelementen innerhalb des Blocks, der die höchste Korrelation zwischen aufeinanderfolgenden Elementen in der Sequenz hat, als eine ausgewählte Sequenz, und wobei die Auswähleinrichtung angeordnet ist, um die Bildelemente in der ausgewählten Sequenz zu liefern.
- 40 6. Vorrichtung zum Codieren eines Bildes nach Anspruch 5, bei der die Auswähleinrichtung (4, 81, 82) zum Auswählen der ausgewählten Sequenz aufweist:
 - (i) eine Vergleichseinrichtung (2) zum Vergleichen von Bildelementen des Blocks mit jenen des entsprechenden Blocks eines vorher codierten Bildes, um eine Matrix von Werten zu erzeugen, wobei jeder Wert anzeigt, ob von dem entsprechenden Element gemäß einem vorbestimmten
45 Kriterium angenommen wird, daß es sich zwischen zwei Blöcken geändert hat;
 - (ii) eine Einrichtung (4) zum Auswählen einer Matrix aus einer vorbestimmten Menge von Standardmatrizen, von denen jede einen Bereich von Bildelementen des Blocks identifiziert, von denen angenommen wird, daß sie sich geändert haben, und zwar durch Abgleichen der Matrix mit der Menge von Standardmatrizen, wobei es eine vorbestimmte Codiersequenz gibt, die zu jeder der
50 Standardmatrizen gehört;
 - (iii) eine Codiereinrichtung (8) zum Codieren zur Ausgabe jener Elemente innerhalb des identifizierten Bereichs, von denen angenommen wird, daß sie sich geändert haben, wobei die Codiersequenz der Elemente jene ist, die zu der ausgewählten Matrix gehört.
- 55 7. Vorrichtung nach Anspruch 6, bei der, wenn der Bereich, der zu einer ausgewählten Matrix von den Standardmatrizen gehört, von einer im allgemeinen vertikal sich erstreckenden verlängerten Gestalt (f, g, h) ist, die Codiersequenz durch eine Abtastung des Bereichs in vertikalen Ablenkungen (Fig. 4) festgelegt ist und, wenn der Bereich von einer im allgemeinen horizontal sich erstreckenden verlänger-



ten Gestalt (b, c, d) ist, die Codiersequenz durch eine Abtastung des Bereichs in horizontalen Ablenkungen (Fig. 5) festgelegt ist.

8. Vorrichtung nach einem der Ansprüche 5, 6 oder 7, bei der die Codiereinrichtungen (8) angeordnet sind, um die Darstellungen in der Reihenfolge der ausgewählten Sequenz auszugeben.
9. Vorrichtung nach einem der Ansprüche 6, 7 oder 8, bei der die Vergleichseinrichtungen aufweisen:
 - eine Einrichtung (10) zum Bilden eines ersten Änderungssignals, das den Unterschied zwischen jedem Bildelement eines laufenden Rahmens des Videosignals und eines vorherigen Rahmens des Signals darstellt;
 - eine Filtereinrichtung (11, 12, ..., 20) zum Bilden einer gewichteten Summe der ersten Änderungssignale, die bezüglich eines gerade betrachteten Bildelements und bezüglich Bildelementen, die räumlich daran benachbart sind, gebildet werden, und zum Vergleichen der Summe mit einer Schwelle;
 - eine Einrichtung (21) zum Bilden eines zweiten Änderungssignals, das den Unterschied zwischen jedem Bildelement eines laufenden Rahmens des Videosignals und eines vorherigen Rahmens des Signals darstellt, und zum Vergleichen des zweiten Änderungssignals mit einer Schwelle; und
 - eine Einrichtung (22), die bei Betrieb angeordnet ist, um eine Änderungsanzeige für ein Bildelement auszugeben, und zwar nur wenn beide Schwellen überschritten werden.
10. Decodierer zum Decodieren von Signalen, die unter Verwendung des Verfahrens nach einem der Ansprüche 1, 2, 3 oder 4 codiert sind, wobei der Decodierer aufweist:
 - eine Einrichtung (34, 35) zum Empfangen von Differentialwerten und zum Berechnen von deren Absolutwerten; und
 - eine Einrichtung (36, 38, 39) zum erneuten sequentiellen Ordnen, die bei Verwendung auf empfangene Codes anspricht, die die gewählte Sequenz anzeigen, um die Sequenz der Absolutwerte zu ändern.

Revendications

1. Un procédé de codage d'une image composée d'une série d'éléments de représentation formant un ou plusieurs blocs d'éléments de représentation, comprenant, pour chaque bloc, l'obtention de représentations de ces éléments de représentation dans une séquence venant d'un codeur différentiel (83-86), dans lequel certaines des représentations sont les différences entre des valeurs de l'élément concerné et d'une prédiction basée sur la valeur d'au moins l'élément immédiatement précédent de ladite séquence caractérisé en ce que le procédé inclut les étapes consistant à: choisir, comme séquence choisie parmi une série de séquences possibles des éléments de représentation à l'intérieur du bloc, la séquence dans laquelle la corrélation entre des éléments successifs de la séquence est la plus élevée et envoyer audit codeur différentiel (83-86) les éléments de représentation de ladite séquence choisie).
2. Un procédé de codage d'une image selon la revendication 1 dans lequel le choix de la séquence choisie est effectué:
 - (i) en comparant des éléments de représentation du bloc avec ceux du bloc correspondant d'une image codée précédemment afin de produire une matrice de valeurs, chaque valeur indiquant s'il est estimé, selon un critère prédéterminé, que l'élément correspondant a varié d'un bloc à l'autre,
 - (ii) choisir, dans un ensemble prédéterminé de matrices normalisées dont chacune identifie une région d'éléments de représentation du bloc, une matrice qui, selon l'estimation, a varié en mettant en concordance la matrice avec l'ensemble des matrices normalisées, une séquence prédéterminée de codage étant associée à chacune des matrices normalisées;
 - (iii) coder, afin de les produire, les éléments situés à l'intérieur de la région identifiée qui, selon l'estimation, ont varié, la séquence de codage des éléments étant celle qui est associée à la matrice choisie.
3. Un procédé selon la revendication 2 dans lequel la séquence de codage est définie par une exploration de la région par des balayages verticaux, lorsque la région associée à une matrice choisie parmi les matrices normalisées est d'une configuration allongée s'étendant généralement à la verticale, et la séquence de codage est définie par une exploration de la région par des balayages horizontaux, lorsque la région est d'une configuration allongée s'étendant généralement à l'horizontale.



4. Un procédé selon l'une quelconque des revendications 1, 2 ou 3 dans lequel les représentations sont produites dans la séquence choisie.
5. Un appareil de codage d'une image (Fig. 1) composé d'une série d'éléments de représentation, formant un ou plusieurs blocs d'éléments de représentation comprenant un codeur différentiel (83-86) pour produire des représentations des éléments de représentation, de chaque bloc, dans une séquence dans laquelle certaines des représentations sont les différences entre des valeurs de l'élément concerné et d'une prédiction basée sur la valeur d'au moins l'élément immédiatement précédent de ladite séquence, caractérisé en ce que l'appareil inclut:
 - 10 un moyen de choix (4, 81, 82) pour choisir, comme séquence choisie parmi une série de séquences possibles d'éléments de représentation à l'intérieur du bloc, celle où la corrélation entre éléments successifs de la séquence est la plus élevée, et en ce que l'appareil est agencé pour produire les éléments de représentation dans ladite séquence choisie.
- 15 6. Un appareil de codage d'une image selon la revendication 5, dans laquelle le moyen de choix (4, 81, 82) servant à choisir la séquence choisie comprend:
 - (i) un moyen de comparaison (2) pour comparer des éléments de représentation du bloc à ceux du bloc correspondant d'une image codée précédemment afin de produire une matrice de valeurs qui indiquent chacune s'il est estimé, selon un critère prédéterminé, que l'élément correspondant a varié d'un bloc à l'autre,
 - (ii) un moyen de choix (4), dans un ensemble prédéterminé de matrices normalisées dont chacune identifie une région d'éléments de représentation du bloc, d'une matrice qui, selon l'estimation, a varié en mettant en concordance la matrice avec l'ensemble des matrices normalisées, une séquence prédéterminée de codage étant associée à chacune des matrices normalisées;
 - 25 (iii) un moyen de codage (8) pour coder, en vue de les produire, les éléments à l'intérieur de la région identifiée qui, selon l'estimation, ont varié, la séquence de codage des éléments étant celle qui est associée à la matrice choisie.
- 30 7. Appareil selon la revendication 6 dans lequel la séquence de codage est définie par une exploration de la région par des balayages verticaux (Fig. 4), lorsque la région associée à une matrice choisie parmi les matrices normalisées est d'une configuration allongée s'étendant généralement à la verticale (f, g, h), et la séquence de codage est définie par une exploration de la région par des balayages horizontaux (Fig. 5), lorsque la région est d'une configuration allongée s'étendant généralement à l'horizontale (b, c, d).
- 35 8. Appareil selon l'une quelconque des revendications 5, 6 et 7 dans lequel le moyen de codage 8 est agencé pour produire la représentation dans l'ordre de la séquence choisie.
- 40 9. Appareil selon l'une quelconque des revendications 6, 7 et 8 dans lequel le moyen de comparaison comprend
 - un moyen (10) de formation d'un premier signal de variation représentatif de la différence entre chaque élément de représentation d'une trame actuelle du signal vidéo et d'une trame précédente du signal;
 - un moyen de filtre (11, 12, ... 20) pour former une somme pondérée des premiers signaux de variation en ce qui concerne l'élément de représentation en cours de considération, et des éléments de représentation qui lui sont adjacents dans l'espace, et comparer la somme à un seuil,
 - 45 un moyen (21) de formation d'un deuxième signal de variation représentatif de la différence entre chaque élément de représentation d'une trame actuelle du signal vidéo et d'une trame précédente du signal, et comparer le deuxième signal de variation à un seuil;
 - 50 un moyen (22) agencé pour ne fournir en fonctionnement une indication de variation d'un élément de représentation que si les deux seuils sont dépassés.
10. Un décodeur servant au décodage de signaux encodés en utilisant le procédé selon l'une quelconque des revendications 1, 2, 3, et 4 comprenant:
 - 55 un moyen (34, 35) de réception de valeurs différentielles et de calcul de leurs valeurs absolues; et
 - un moyen de remise en séquence (36, 38, 39) sensible, en utilisation, à des codes reçus indiquant la séquence choisie afin de modifier la séquence des valeurs absolues.