A hybrid Discrete Cosine Transform (DCT) coder processes blocks of (e.g., 8x8) pixels from interlaced or progressive scanned image signals. Processing of image lines by the coder is modified in the presence of image motion to avoid switching between 8x8 and 2x(4x8) transformations. For motion, the lines of two vertically superimposed image blocks are rearranged to produce first and second modified blocks. The modified first block contains pixels from lines in a first field, and the modified second block contains pixels from lines in an associated adjacent second field.
ABSTRACT

A hybrid Discrete Cosine Transform (DCT) coder processes blocks of (e.g., 8X8) pixels from interlaced or progressive scanned image signals. Processing of image lines by the coder is modified in the presence of image motion to avoid switching between 8X8 and 2X(4X8) transformations. For motion, the lines of two vertically superimposed image blocks are rearranged to produce first and second modified blocks. The modified first block contains pixels from lines in a first field, and the modified second block contains pixels from lines in an associated adjacent second field.
Method for the coding of picture signals

The invention relates to a method for the coding of picture signals.

BACKGROUND OF THE INVENTION

This invention relates to a system for coding image signals such as by means of a DCT (Discrete Cosine Transform), for example.

A transformation circuit for facilitating an 8*8 or a 2*(4*8) DCT transformation is described in DE 36 42 664.

Switching between an 8*8 and a 2*(4*8) DCT may be accomplished in response to the state of a logic level on a control line.

SUMMARY OF THE INVENTION

An object of the invention is to provide a system for coding image signals by means of a codec suitable for processing both progressively scanned and interlace scanned image signals.

In a system according to the present invention, before coding with a hybrid coder which can process blocks of progressively scanned picture elements (pixels), line sections from respective blocks of interlace scanned picture elements within two vertically superimposed blocks are arranged such that only line sections from one field of an image signal are contained within each of these blocks. Image motion is detected and the line sections are re-sorted within the superimposed blocks in the presence of dynamic image content.

According to a method for hybrid coding of image signals proposed by ISO-MPEG (International Organisation for Standardization, Motion Picture Expert Group) under Standard Proposal number ISO 11172, progressively scanned input signals
are DCT processed in blocks, whereby respective blocks of 8*8 picture elements are coded or decoded and a sequence of inter-frame coded images is replaced as regular intervals by intra-frame coded images. The effectiveness of the coding is also a function of the relatively high spatial correlation of picture elements within such blocks. If interlaced source signals are to be processed by such a hybrid decoded, coding effectiveness decreases if dynamic image content or the data rate required for coding increases. This results because every second line derives from a block having different phases of motion, and correlation of picture elements within such a block decrease. In contrast, coding effectiveness is maintained in the presence of a static image. With a dynamic image, image lines associated with a first field from two superimposed 8*8 picture element blocks are now combined into a first 8*8 block, and lines associated with a corresponding second field from these two superimposed 8*8 picture element blocks are combined into a second 8*8 block, and are applied in this form to the hybrid coder.

Due to such reorganisation of the input signals, it is not necessary to switch between 8*8 and a 2*(4*8) DCT transformation in the hybrid coder as in DE 36 42 664. Instead, an 8*8 DCT can also be advantageously performed for a dynamic image.

A motion detector indicates whether a static of dynamic image is present, and re-sorting or addressing of the lines is done accordingly. Such motion information may be added to the coded data for the respective block by means of a bit per block or double block. During decoding, the corresponding lines are arranged in the original sequence whereby the motion information is evaluated. According to the MPEG standard, four luminance picture element blocks arranged in the shape of a square are combined into a macroblock.
Advantageously, two of the superimposed blocks of such a macroblock form a pair in the above-mentioned sense. Accordingly, one bit per macroblock can indicate the resorting.

The invention may be summarized according to a first broad aspect as a method for coding a signal representing an interlace scanned image with pixel blocks of predetermined size, using a hybrid coder suitable for transforming pixel blocks, comprising the steps of: (a) for blocks with static picture content, transforming square pixel blocks of said predetermined size with an original line structure, wherein said blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels; (b) for blocks with moving picture content, re-arranging the original line structure of the interlace scanned image so as to produce first and second vertically adjacent square pixel blocks of said predetermined size, each said first block containing pixels associated with image lines of a first field, said second block containing pixels associated with image lines of an associated adjacent second field; (c) transforming said first and second blocks in the presence of motion in the picture content, wherein in each case two pairs of said first and second blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels; (d) generating, for each said group of four blocks, a control signal indicating the occurrence of said re-arranging of said line structure in all blocks of a group; and (e) adding said control signal to a coded signal produced by transforming said blocks.

A signal coded as set out in the preceding paragraph may be decoded according to another broad aspect of the
invention in a method comprising the steps of: (a) upon evaluating said control signal, either inverse transforming the transformed pixel blocks with an original line structure in the presence of static picture content, wherein the inversely transformed pixel blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels; or (b) inverse transforming the transformed first and second blocks in the presence of motion in the picture content; and (c) after said inverse transforming, re-arranging said line structure of said inversely transformed first and second blocks back to said original line structure, wherein in each case two pairs of the inversely transformed first and second blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels.

According to another aspect the invention provides an apparatus for coding a signal representing an interlace scanned image with pixel blocks of predetermined size, comprising: means for temporarily storing pixel blocks; a hybrid coder including means for transforming the temporarily stored pixel blocks, which coder: (a) for blocks with static picture content, transforms square pixel blocks of said predetermined size with an original line structure, wherein said blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels; (b) for blocks with moving picture content, re-arranges the original line structure of the interlace scanned image so as to produce first and second vertically adjacent square pixel blocks of said predetermined size, each said first block containing pixels associated with image lines of a first field, said second block containing pixels associated with image lines of an associated adjacent second field; (c) transforms said
first and second blocks in the presence of motion in the picture content, wherein in each case two pairs of said first and second blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels; means for generating, for each said group of four blocks, a control signal indicating the occurrence of said re-arranging of said line structure in all blocks of a group, wherein said control signal is added to a coded signal produced by transforming said blocks.

According to another aspect the invention provides apparatus for decoding a signal which has been coded according to the inventive method, the apparatus comprising: evaluation means for evaluating the control signal; inverse transform means for selectively inverse transforming the transformed pixel blocks with an original line structure in the presence of static picture content, wherein the inversely transformed pixel blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels or inverse transforming the transformed first and second blocks in the presence of motion in the picture content; and rearrange means for after said inverse transforming, re-arranging said line structure of said inversely transformed first and second blocks back to said original line structure, wherein in each case two pairs of the inversely transformed first and second blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 illustrates the location of image lines within blocks for static (a) and dynamic (b) images.
FIG. 2 is a block diagram codec apparatus in accordance with the invention.

FIGS. 3 and 4 are flow diagrams respectively depicting encoder and decoder processing methods in accordance with the principles of the invention.

FIG. 1a and FIG. 1b respectively show two superimposed blocks of luminance or chrominance picture elements in the x-y plane. For simplicity of illustration, the blocks each have a size of 4*4 picture elements instead of a size of 8*8 picture elements. In general, the blocks could also have a size of \((2^n) \times (2^m)\) where \(n = 1, 2, 3, \ldots\), \(m = 1, 2, 3, \ldots\), instead of 8*8. The two digit numbers respectively mark the spatial position of a picture element. The first digit of this number represents the block number, the second, the line number within a block.

The picture elements of the known hybrid coder which are to be coded or decoded in progressively scanned form are arranged in accordance with FIG. 1a. This likewise applies for picture elements having static picture content for interlace scanned picture elements. Before the coding in the case of dynamic picture content, the lines of two superimposed blocks are interchanged in accordance with FIG. 1b and after the decoding, they are re-arranged in accordance with FIG. 1a. FIG. 2 shows a hybrid coder 25 corresponding to the aforesaid Standard Proposal. Interlace scanned picture signals from
picture n are supplied to the input 21 and thence arrive in a picture store 22 and a movement detector 24. The items of data (two superimposed blocks) of picture n-1 needed by the movement detector 24 and the line sections of the respective two blocks involved are read out from the picture store 22 into a block store 23, from which the hybrid coder is able to select 8*8 blocks on each occasion. The picture elements for static picture content corresponding to Fig. 1a and those for dynamic picture content corresponding to Fig. 1b are buffer stored in the block store 23.

The movement detector can be realised in accordance with various known methods. For example, the absolute value differences of picture elements from blocks having the same spatial position of picture n and picture n-1 may be formed for each block or double block that has to be coded. Alternatively, movement vectors (e.g. for two superimposed blocks on each occasion) formed by the hybrid coder 25 can be used instead of the movement detector. If the instantaneous sum of these absolute value differences and/or the amount of the corresponding movement vectors for this block or these blocks exceeds a predetermined threshold (i.e. dynamic picture content is involved), the picture elements corresponding to Fig. 1b, otherwise those corresponding to Fig. 1a, are buffer stored in the block store 23.

The re-sorting may be undertaken in accordance with the following listing:

```fortran
DO y = 1,N/2
   DO x = 1,N
      B_out1(x,y) = B_in1(x,2*y-1)
      B_out1(x,y) = B_in1(x,2*y)
   ENDDO
ENDDO
DO y = 1,N/2
   DO x = 1,N
      B_out1(x,y+N/2) = B_in2(x,2*y-1)
      B_out1(x,y+N/2) = B_in2(x,2*y)
   ENDDO
ENDDO,
```
wherein, $B_{in1}$ is the block located in the higher position and $N$ is an even number.

FIG. 3 is a flow chart illustrating a method as described above in accordance with the principles of the invention. In method step 30 an input signal is evaluated to determine if it exhibits interlaced or progressive scan form. A progressive scan signal is transformed and coded without further processing at step 32 via node 31. If an interlaced signal is detected at step 30, the interlaced signal is evaluated at step 34 to determine if it contains motion. If it does not, the interlaced signal is coupled via step 36 without rearranging its original line structure to step 32 where the interlaced signal is transformed and coded. If step 34 senses that the interlaced signal contains motion, the processing of step 36 is controlled so as to rearrange the line structure of the interlaced signal (as previously discussed). The interlaced signal with rearranged line structure is transformed and subsequently coded by step 32. In step 38 a control signal indicating a rearranged line structure when an interlaced signal with motion is detected is provided to the coding function in step 32. The coding function in step 32 may provide a motion vector to motion detection step 34 to indicate a motion condition for rearranging the line structure of an interlaced signal. Picture and block storage steps as may be required to facilitate the process illustrated by FIG. 3 have been discussed previously in connection with FIG. 2 and have not been shown to simplify FIG. 3.

FIG. 4 is a flowchart illustrating decoder processing steps associated with the coding process discussed in connection with FIG. 3. An input signal transform coded as discussed previously is decoded and inverse transformed by step 40. Before being applied to an output, the decoded signal is
processed by a step 42, which rearranges the line structure back to an original structure if the signal exhibits an interlaced line format with motion. For this purpose step 44 determines if the input signal exhibits an interlaced line structure. If it does, step 46 determines if the interlaced signal contains motion. If motion is detected, a control signal is provided to step 42 to effect rearranging of the lines of the interlaced signal back to an original structure.
CLAIMS:

1. A method for coding a signal representing an interlace scanned image with pixel blocks of predetermined size, using a hybrid coder suitable for transforming pixel blocks, comprising the steps of:

   (a) for blocks with static picture content, transforming square pixel blocks of said predetermined size with an original line structure, wherein said blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels;

   (b) for blocks with moving picture content, re-arranging the original line structure of the interlace scanned image so as to produce first and second vertically adjacent square pixel blocks of said predetermined size, each said first block containing pixels associated with image lines of a first field, said second block containing pixels associated with image lines of an associated adjacent second field;

   (c) transforming said first and second blocks in the presence of motion in the picture content, wherein in each case two pairs of said first and second blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels;

   (d) generating, for each said group of four blocks, a control signal indicating the occurrence of said re-arranging of said line structure in all blocks of a group; and

   (e) adding said control signal to a coded signal produced by transforming said blocks.

2. A method according to claim 1, comprising the further step of:
re-arranging said line structure in response to an output signal from a motion detector.

3. A method according to claim 1, comprising the further step of:

re-arranging said line structure in response to a motion vector generated by said hybrid coder.

4. A method according to claim 1, wherein for movement detection for each of the pixel blocks or first and second blocks to be coded the differences in the absolute values of pixels from blocks of the same spatial position of two successive pictures are formed, such that, if the sum of these absolute value differences for a current pixel block or current first and second blocks exceeds a predetermined threshold, said re-arranging takes place.

5. A method according to claim 1, wherein said re-arranging of the line structure is either a re-sorting of line sections or a re-addressing of line sections.

6. A method for decoding a signal representing an interlace scanned image with pixel blocks of predetermined size, said signal having been coded according to the method of claim 1 using a hybrid coder suitable for transforming pixel blocks, the decoding method comprising the steps of:

(a) upon evaluating said control signal, either inverse transforming the transformed pixel blocks with an original line structure in the presence of static picture content, wherein the inversely transformed pixel blocks area arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels; or
(b) inverse transforming the transformed first and second blocks in the presence of motion in the picture content; and

(c) after said inverse transforming, re-arranging said line structure of said inversely transformed first and second blocks back to said original line structure, wherein in each case two pairs of the inversely transformed first and second blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels.

7. A method according to claim 6, wherein the re-arranging of the line structure is either a re-sorting of line sections or a re-addressing of line sections.

8. An apparatus for coding a signal representing an interlace scanned image with pixel blocks of predetermined size, comprising:

   means for temporarily storing pixel blocks;

   a hybrid coder including means for transforming the temporarily stored pixel blocks, which coder:

   (a) for blocks with static picture content, transforms square pixel blocks of said predetermined size with an original line structure, wherein said blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels;

   (b) for blocks with moving picture content, re-arranges the original line structure of the interlace scanned image so as to produce first and second vertically adjacent square pixel blocks of said predetermined size, each said first block containing pixels associated with image lines of a first
field, said second block containing pixels associated with image lines of an associated adjacent second field;

(c) transforms said first and second blocks in the presence of motion in the picture content, wherein in each case two pairs of said first and second blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels;

means for generating, for each said group of four blocks, a control signal indicating the occurrence of said rearranging of said line structure in all blocks of a group,

wherein said control signal is added to a coded signal produced by transforming said blocks.

9. An apparatus for decoding a signal representing an encoded interlace scanned image with pixel blocks of predetermined size, said signal having been coded according to the method of claim 1, the apparatus comprising:

evaluation means for evaluating the control signal;

inverse transform means for selectively inverse transforming the transformed pixel blocks with an original line structure in the presence of static picture content, wherein the inversely transformed pixel blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels or inverse transforming the transformed first and second blocks in the presence of motion in the picture content; and

rearrange means for after said inverse transforming, re-arranging said line structure of said inversely transformed first and second blocks back to said original line structure,
wherein in each case two pairs of the inversely transformed first and second blocks are arranged within a group of four blocks arranged in a square pattern, each block of said group comprising 8*8 luminance pixels.
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