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(54) **VIDEO CODER EMPLOYING PIXEL TRANSPORTATION**

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    G06K 9/40   (2006.01)
    G06T 5/00   (2006.01)
    H03M 13/47   (2006.01)

(52) **U.S. Cl.** **382/268**; 382/275; 358/463; 348/608; 375/240.27; 375/E7.19; 375/E7.228; 375/E7.241

(58) **Field of Classification Search** 382/268, 382/275, 254, 250, 251; 375/240.27, 240.26, 375/240.2, 240.24, 240.29; 348/608
See application file for complete search history.

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Primary Examiner—Scott A Rogers

(57)   **ABSTRACT**

A video encoding method and apparatus is shown wherein image information is represented as a plurality of pixels, the pixels are organized into blocks, pixels transposition is performed on image information at the boundaries of the blocks, the blocks are transform coded and quantized. Pixel transposition involves transposition of alternate pixels at the boundaries of blocks with pixels of neighboring blocks found in a pre-determined direction. The pre-determined direction may be fixed by a system or may be applied on an image by image basis. In the event that the pre-determined direction is not established by a system, a pixel transposition circuit includes a transposition keyword in the output bit stream which is used by a decoded to determine the direction of pixel transposition.

52 Claims, 2 Drawing Sheets
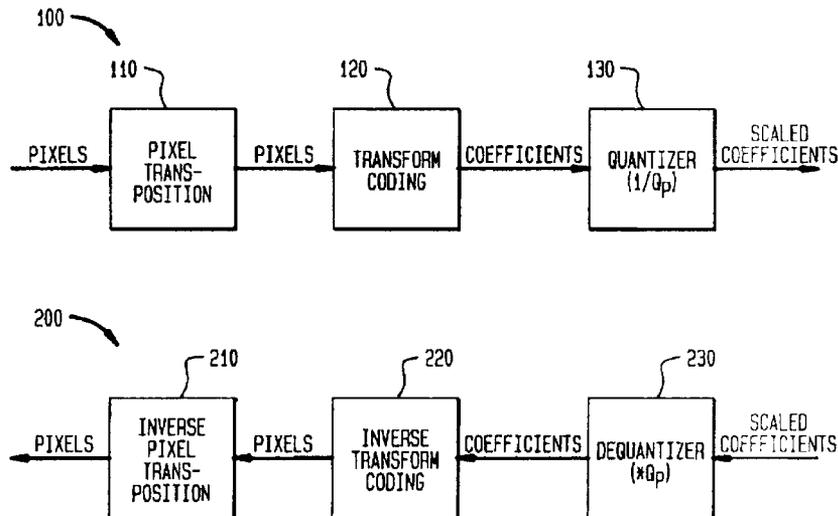
FIG. 1 (a)
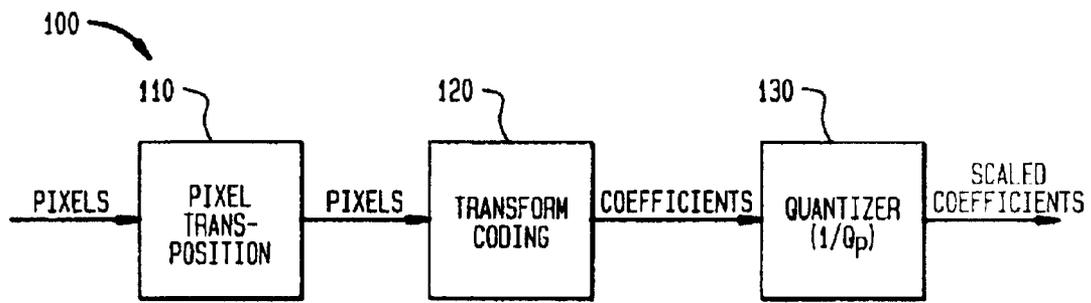
FIG. 1 (b)

FIG. 2(a)

FIG. 2(b)

VIDEO CODER EMPLOYING PIXEL TRANSPORTATION

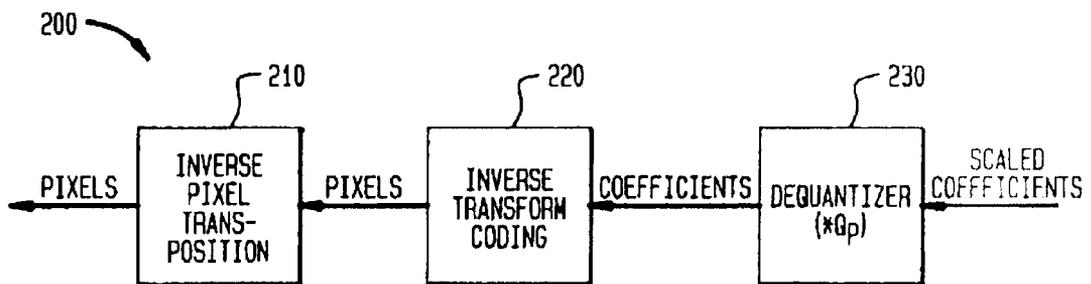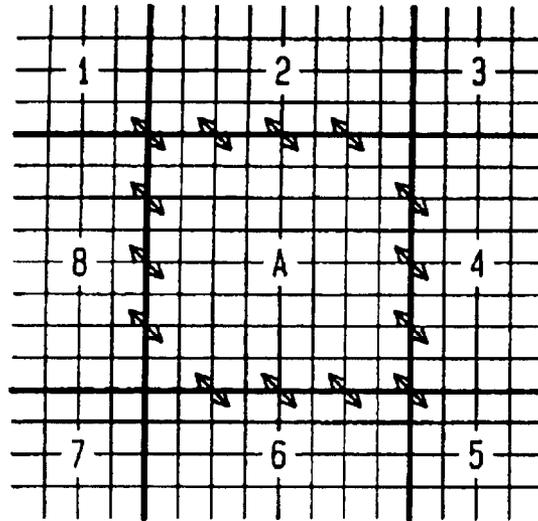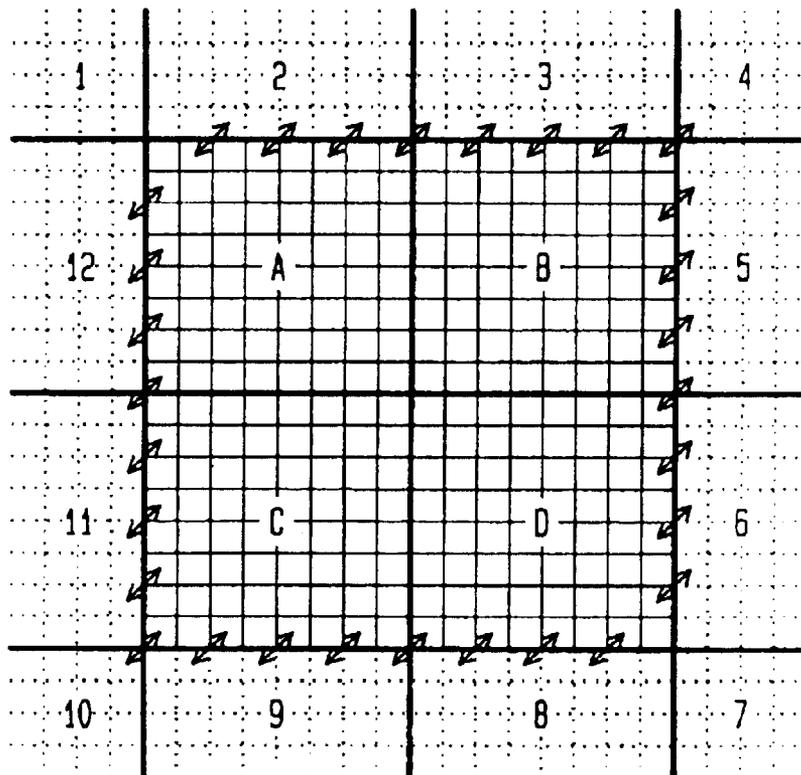**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.**

BACKGROUND OF THE INVENTION

The present invention relates to block based video coding schemes and, most particularly, to a method of eliminating artifacts at block boundaries by transposing pixels at block boundaries with pixels from boundaries of neighboring blocks before coding.

Known systems for coding video information advantageously employ transform coding of a plurality of blocks or macro blocks. In such systems, image data often are filtered, broken down into a luminance component and two chrominance components, and organized into blocks of image data. For example, according to the proposed MPEG-4 video standard, image data are organized first into blocks, each containing an 8 pixel by 8 pixel array of data, then into macro blocks including up to four luminance blocks and two chrominance blocks. The blocks of image data are then transform coded from a pixel domain to an array of transform coefficients and scaled by a quantization parameter and transmitted in an output bit stream.

Block-based transform coding is preferred over other known coding schemes, such as wavelet coding, because it is relatively less complex to implement. However, such block-based transform coding causes annoying artifacts in the reconstructed image. Quantization parameters may be established for each block or macro block of image data. Differences in quantization parameters among the various blocks or macro blocks result in distortion at the block boundaries. For instance, in flat image areas, such distortions impose a patchwork effect on reconstructed image data. Similar artifacts appear in image areas having heavy texture, but are less noticeable. Block based coding with variable quantization causes additional artifacts to arise, such as chromo-bleeding, "mosquito-noise" and "ringing" artifacts.

Prior systems have attempted to ameliorate the effect of such artifacts by low pass filtering reconstructed image data at block boundaries. However, while low pass filtering reduces block artifacts, it also causes blurring of image data. Low pass filtering impairs image quality.

There is a need in the art for an image coder that advantageously employs block-based transform coding and quantization but reduces image artifacts at block boundaries. Further, there is a need in the art for a coding scheme that reduces artifacts without unnecessarily blurring image data.

SUMMARY OF THE INVENTION

The disadvantages of the prior art are alleviated to a great extent by an image coding scheme that employs block-based transform coding and quantization. An encoder transposes pixels across block boundaries in a predetermined direction prior to transform coding. For example, alternate pixels along a boundary of a first block may be transposed with adjacent pixels in a diagonal direction of neighboring blocks. After transposition, each reformed block undergoes transform coding and quantization.

A decoder performs reverse operations of those employed by the encoder. Each coded block is dequantized and coded by an inverse transform to reconstruct blocks of pixel infor-

mation. At the conclusion of the inverse transform, pixels that were subject to transposition are returned to the neighboring blocks from which they originated. After transposition, each block may be processed further for display.

The pixel transposition reduces image artifacts at block boundaries and improves image quality, particularly in flat image areas. By including cross border pixels in the transform coding and quantization, the transform coding and quantization are performed with greater uniformity on image data.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1(a) and 1(b) respectively illustrate an encoder **100** and a decoder **200** according to an embodiment of the present invention.

FIGS. 2(a) and 2(b) respectively illustrate the pixel transposition operation of the present invention as applied to blocks and macro blocks of image data.

DETAILED DESCRIPTION

Turning to FIG. 1(a), circuitry of an encoder **100** is illustrated therein constructed in accordance with an embodiment of the present invention. Blocks or macro blocks of image data are input to a pixel transposition circuit **110**. Each block possesses one of luminance or chrominance image data. The pixel transposition circuit **110** transposes specific pixels from the boundary of each block or macro block with pixels from its neighbors. The pixel transposition circuit **110** then outputs reconstituted blocks of pixel data to a transform coder **120**. The transform coder **120** performs a transform of the block data from a pixel domain to a domain of coefficients representative of the pixel data. For example, the transform coder **120** may perform a discrete cosine transform as is known in the art. The transform coder **120** outputs blocks of coefficient data to a quantizer **130**. For each block or macro block, the quantizer **130** generates a quantizer parameter (Q_p) based upon the bandwidth of a channel available to transmit the coded image data. The quantizer **130** scales the coefficients of the block by the quantization parameter. The quantizer **130** outputs blocks of scaled coefficient information and the quantization parameters generated for each for further processing and transmission.

FIG. 1(b) illustrates circuitry of a decoder **200** constructed in accordance with an embodiment of the present invention. Blocks of scaled coefficients are isolated from the transmitted bit stream and input to a dequantizer **230**. The dequantizer **230** identifies the quantization parameter for each block and scales the scaled coefficients of the block by the quantization parameter. Where the quantizer **130** may have divided each coefficient by Qp, the dequantizer multiplies the scaled coefficients by the same Qp to obtain the original coefficients. The dequantizer **230** outputs reconstructed coefficient data to an inverse transform coding circuit **220**. The inverse transform coding circuit **220** transforms the coefficients back to the pixel domain, such as by discrete transform coding. The inverse transform coding circuit **220** outputs blocks or macro blocks of reconstructed pixel data to an inverse pixel transposition circuit **210**. For each block or macro block, the inverse pixel transposition circuit **210** transposes pixels along its boundary with pixels of its neighbors in a direction complementary to the process applied by the pixel transposition circuit **110**. The inverse pixel transposition circuit **210** returns pixels to their original position in the neighboring blocks or macro blocks. The inverse pixel transposition circuit **110** outputs blocks of pixel information for further processing and display.

An example of a pixel transposition process is shown in FIG. **2**(a) applied on a block by block basis. For each block A, the pixel transposition circuit **110** stores, in memory, pixel information from a plurality of surrounding Blocks **1**–**8**. The pixel transposition circuit **110** transposes pixel information in a predetermined direction. In the example of FIG. **2**(a), the pixels are transposed along a diagonal direction from high-left to low-right and vice versa.

Under the pixel transposition process, each alternate pixel on the edge of a given block A is transposed with a pixel across the block boundary in the predetermined direction. In the example of FIG. **2**(a), the pixel in the upper left-hand corner of block A is transposed with a pixel in the lower right-hand corner of block **1**. Three pixels along the upper edge of block A are transposed with pixels on the lower edge of block **2** in the same diagonal direction. Alternate pixels found on the right-hand edge of block A are transposed with pixels on the left-hand edge of block **4** in the diagonal direction. The pixel in the lower right-hand corner of block A is transposed with a pixel in the upper left-hand corner of block **5**. Alternate pixels on the lower edge of block A are transposed with pixels on the upper edge of block **6** in the diagonal direction. Finally, alternate pixels on the left hand edge of block **8** are transposed with pixels found on the right-hand edge of block **8** in the diagonal direction.

Pixel transposition is performed only on like-kind data. When performing pixel transposition on a luminance block, the pixel transposition circuit **110** considers only neighboring luminance blocks for transposition. Similarly, for blocks of each of the two chrominance signals, pixel transposition is performed only with neighboring chrominance image blocks of the same type.

FIG. **2**(b) illustrates an example where pixel transposition is performed on a macro block by macro block basis. In the event that the quantizer circuit **130** computes quantization parameters for each macro block rather than for each block, it is preferable to perform a pixel transposition on a macro block by macro block basis. In this example, a macro block consists of four blocks of image information, Blocks A–D. The macro block is surrounded by twelve neighboring blocks, Blocks **1**–**12**. For the macro block, pixel transposition is performed on alternate pixels on the boundary of the macro block with pixel information of neighboring macro blocks along a pre-determined direction. In this example, the predetermined direction is from low-left to high-right and vice versa. As shown in FIG. **2**(b), the pixel in the upper right-hand corner of Block B is transposed with a pixel in the lower left-hand corner of Block **4**. Similarly, a pixel in a lower left-hand corner of Block C is transposed with a pixel in the upper right-hand corner of Block **10**. Alternate pixels on the top edge of the macro block, the top edges of Blocks A and B, are transposed with pixels on the bottom edges of Blocks **2** and **3** in a diagonal direction. Pixels on the right-hand edge of the macro block, the right-hand edges of Blocks B and D, are transformed on the left-hand edges of Blocks **5** and **6** in the diagonal direction. Blocks on the lower edge of the macro block, the lower edges of Blocks C and D, are transposed with pixels found in the diagonal direction on the upper edges of Blocks **8** and **9**. Finally, pixels found on the left-hand edge of the macro block, the left-hand edges of Blocks A and C, are transposed with pixels found in a diagonal direction in the right-hand edges of Blocks **11** and **12**.

The direction of transposition is arbitrary. Any direction may be applied. In addition to high-left to low-right and low-left to high-right, horizontal (right to left) and vertical (above to below) directions may be applied. The direction may be predetermined by the system or defined for each

coded video frame. If the direction of transposition is variable, the pixel transposition circuit **110** includes a transposition keyword in the output bitstream identifying the direction of transposition. The decoder identifies the transposition keyword and identifies a direction of transposition therefrom.

So, too, the pattern of transposition may varied. In addition to selection of alternate pixels for transposition, every third or every fourth pixel may be selected for transposition. Further, the pattern may varied so as to select pixels at a first rate, such as every other pixel, in a first region of data, then a second rate, such as every fourth pixel, in a second region of data.

The encoder **100** and decoder **200** shown in FIGS. **1**(a) and **1**(b) are not full video coders. Preprocessing is generally performed on pixels before they are input to the pixel transposition circuit **110**, which generally involves sampling of image data, conversion to a digital format, filtering, and component isolation. Preprocessing also includes organization of the component signals into blocks. However, in a preferred embodiment, preprocessing functions may be merged into the pixel transposition circuit **110**. In this case, the pixel transposition circuit may be programmed to reorder pixels before they are organized into blocks.

We claim:

[**1**. A video coder, comprising:

a pixel transposition circuit that receives blocks of image data, each block including image data of an array of pixels, said pixel transposition circuit transposing selected pixels on a boundary of a first block with selected boundary pixels of a plurality of blocks neighboring said first block,

a transform circuit that generates coefficients representative of data of the transposed blocks, and

a quantizer that scales the coefficients.]

[**2**. The video coder of claim **1**, wherein the pixel transposition circuit transposes alternate pixels along the boundary of said first block with pixels from the neighboring blocks adjacent to the alternate pixels in a transposition direction.]

[**3**. The video coder of claim **2** wherein the transposition direction is a diagonal direction, high-left to low-right.]

[**4**. The video coder of claim **2** wherein the transposition direction is a diagonal direction, low-left to high-right.]

[**5**. The video coder of claim **2**, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first block and a horizontal direction for pixels along a horizontal edge of the first block.]

[**6**. A video decoder, comprising:

a dequantizer that receives blocks of scaled coefficient information and reconstructing coefficients therefrom,

an inverse transform circuit that reconstructs blocks of pixel data from the blocks of reconstructed coefficients, and

a pixel transposition circuit that transposes pixels on a boundary of a first block with boundary pixels of a plurality of blocks neighboring said first block and generating blocks of image data for display.]

[**7**. The video decoder of claim **6**, wherein the pixel transposition circuit transposes alternate pixels along the boundary of the first block with pixels from the neighboring blocks adjacent to the alternate pixels in a transposition direction.]

[**8**. The video decoder of claim **7**, wherein the transposition direction is a diagonal direction, high-left to low-right.]

[**9**. The video decoder of claim **7**, wherein the transposition direction is a diagonal direction, low-left to high-right.]

[**10**. The video decoder of claim **7**, wherein the transposition direction is a vertical direction for pixels along a vertical

edge of the first block and a horizontal direction for pixels along a horizontal edge of the first block.]

[11. A method of encoding image data, comprising the steps of:

receiving blocks of image data, each block including data for an array of pixels,

transposing selected pixels on a boundary edge of a first block with selected pixels from a plurality of blocks neighboring said first block,

transforming pixel data of the blocks from the step transposing to coefficients, and

scaling the transformed blocks.]

[12. The method of claim 11, wherein the transposition step includes transposing alternate pixels along the boundary of the first block with pixels from the neighboring blocks adjacent to the alternate pixels in a transposition direction.]

[13. The method of claim 12, further comprising a step of generating a transposition keyword representative of the transposition direction.]

[14. The method of claim 12, wherein the transposition direction is a diagonal direction, high-left to low-right.]

[15. The method of claim 12, wherein the transposition direction is a diagonal direction, low-left to high-right.]

[16. The method of claim 12, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first block and a horizontal direction for pixels along a horizontal edge of the first block.]

[17. A method of decoding blocks of encoded image data, comprising the steps of:

scaling the coded blocks to obtain blocks of coefficient data,

transforming the coefficient data of the blocks to pixel data, and

transposing selected pixels on a boundary edge of a first block with selected pixels from a plurality of blocks neighboring said first block.]

[18. The method of claim 17, wherein the transposition step transposes alternate pixels along the boundary of the first block with pixels from the neighboring blocks adjacent to the alternate pixels in a transposition direction.]

[19. The method of claim 18, further comprising a step of receiving a transposition keyword that identifies a transposition direction.]

[20. The method of claim 18, wherein the transposition direction is a diagonal direction, high-left to low-right.]

[21. The method of claim 18, wherein the transposition direction is a diagonal direction, low-left to high-right.]

[22. The method of claim 18, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first block and a horizontal direction for pixels along a horizontal edge of the first block.]

[23. A bitstream generated by a process comprising the steps of:

receiving blocks of image data, each block including data for an array of pixels,

transposing selected pixels on a boundary edge of a first block with selected pixels from blocks neighboring the first block,

transforming pixel data of the transposed blocks to coefficients, and

scaling the transformed blocks.]

[24. The method of claim 23, wherein the transposition step includes a step of transposing alternate pixels along the boundary of the first block with pixels from the neighboring blocks adjacent to the alternate pixels in a transposition direction.]

[25. The method of claim 24, further comprising a step of generating a transposition keyword representative of the transposition direction.]

[26. The method of claim 24, wherein the transposition direction is a diagonal direction, high-left to low-right.]

[27. The method of claim 24, wherein the transposition direction is a diagonal direction, low-left to high-right.]

[28. The method of claim 24, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first block and a horizontal direction for pixels along a horizontal edge of the first block.]

29. A method of encoding image data, comprising the steps of:

receiving blocks of image data, each block including an array of pixels;

converting each block of image data into blocks of luminance pixel data and chrominance pixel data;

transposing selected pixel data of adjacent luminance blocks;

transposing selected pixel data of adjacent chrominance blocks;

transforming pixel data of the transposed luminance blocks to luminance coefficients;

transforming pixel data of the transposed chrominance blocks to chrominance coefficients; and

scaling the transformed luminance coefficients and the transformed chrominance coefficients.

30. The method of claim 29, wherein the luminance transposition step includes transposing alternate pixels along a boundary of a first luminance block with pixels from neighboring luminance blocks adjacent to the alternate pixels in a transposition direction.

31. The method of claim 30, further comprising a step of generating a luminance transposition keyword representative of the transposition direction and transmitting the scaled luminance coefficient and the transposition keyword to a channel.

32. The method of claim 30, wherein the transposition direction is a diagonal direction, high-left to low-right.

33. The method of claim 30, wherein the transposition direction is a diagonal direction, low-left to high-right.

34. The method of claim 29, wherein the transposition direction is a vertical direction for pixels along vertical edges of the luminance blocks and a horizontal direction for pixels along horizontal edges of the luminance blocks.

35. The method of claim 29, wherein the chrominance transposition step includes transposing alternate pixels along a boundary of a first chrominance block with pixels from neighboring chrominance blocks adjacent to the alternate pixels in a transposition direction.

36. The method of claim 35, further comprising a step of generating a chrominance transposition keyword representative of the transposition direction and transmitting the scaled chrominance coefficient and the transposition keyword to a channel.

37. The method of claim 35, wherein the transposition direction is a diagonal direction, high-left to low-right.

38. The method of claim 35, wherein the transposition direction is a diagonal direction, low-left to high-right.

39. The method of claim 35, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first chrominance block and a horizontal direction for pixels along a horizontal edge of the first chrominance block.

40. A method of decoding blocks of encoded luminance and chrominance data, comprising:

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scaling blocks of encoded luminance data to obtain blocks of coefficient luminance data;

scaling blocks of encoded chrominance data to obtain blocks of coefficient chrominance data;

transforming the blocks of coefficient luminance data to blocks of luminance data;

transforming the blocks of coefficient chrominance data to blocks of chrominance data;

transposing selected alternate pixels of adjacent luminance blocks;

transposing selected alternate pixels of adjacent chrominance blocks; and

converting luminance blocks and chrominance blocks obtained from the transposings into blocks of image data.

41. The method of claim 40, wherein the converting comprises transform decoding.

42. The method of claim 40, wherein the luminance transposition step transposes alternate pixels along a boundary of a first luminance block with pixels from neighboring luminance blocks adjacent to the alternate pixels in a transposition direction.

43. The method of claim 42, further comprising a step of receiving a transposition keyword that identifies the transposition direction, the transposing occurring according to the identified transposition direction.

44. The method of claim 42, wherein the transposition direction is a diagonal direction, high-left to low-right.

45. The method of claim 42, wherein the transposition direction is a diagonal direction, low-left to high-right.

46. The method of claim 42, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first luminance block and a horizontal direction for pixels along a horizontal edge of the first luminance block.

47. The method of claim 40, wherein the chrominance transposition step transposes alternate pixels along a boundary of a first chrominance block with pixels from neighboring chrominance blocks adjacent to the alternate pixels in a transposition direction.

48. The method of claim 47, further comprising a step of receiving a transposition keyword that identifies a transposition direction.

49. The method of claim 47, wherein the transposition direction is a diagonal direction, high-left to low-right.

50. The method of claim 47, wherein the transposition direction is a diagonal direction, low-left to high-right.

51. The method of claim 47, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first chrominance block and a horizontal direction for pixels along a horizontal edge of the first chrominance block.

52. A video coder, comprising:

an image block conversion circuit that receives blocks of image data, each block including image data of an array of pixels, said image block conversion circuit converting the received blocks of image data into luminance blocks and chrominance blocks;

a pixel transposition circuit that transposes selected pixels of adjacent luminance blocks and transposes selected pixels of adjacent chrominance blocks;

a transform circuit that generates luminance coefficients representative of data of the transposed luminance blocks, and generates chrominance coefficients representative of data of the transposed chrominance blocks; and

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a quantizer that scales the luminance coefficients and the chrominance coefficients.

53. The video coder of claim 52, wherein the pixel transposition circuit transposes alternate pixels along a boundary of a first luminance block with pixels from neighboring luminance blocks adjacent to the alternate pixels in a transposition direction.

54. The video coder of claim 53 wherein the transposition direction is a diagonal direction, high-left to low-right.

55. The video coder of claim 53 wherein the transposition direction is a diagonal direction, low-left to high-right.

56. The video coder of claim 53, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first luminance block and a horizontal direction for pixels along a horizontal edge of the first luminance block.

57. The video coder of claim 52, wherein the pixel transposition circuit transposes alternate pixels along a boundary of a first chrominance block with pixels from neighboring chrominance blocks adjacent to the alternate pixels in a transposition direction.

58. The video coder of claim 57 wherein the transposition direction is a diagonal direction, high-left to low-right.

59. The video coder of claim 57 wherein the transposition direction is a diagonal direction, low-left to high-right.

60. The video coder of claim 57, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first chrominance block and a horizontal direction for pixels along a horizontal edge of the first chrominance block.

61. A video decoder, comprising:

a dequantizer that receives blocks of scaled luminance coefficient information and reconstructs luminance coefficients therefrom, and also receives blocks of scaled chrominance coefficient information and reconstructs chrominance coefficients therefrom;

an inverse transform circuit that reconstructs blocks of luminance pixel data from the blocks of reconstructed luminance coefficients, and also reconstructs blocks of chrominance pixel data from the blocks of reconstructed chrominance coefficients;

a pixel transposition circuit that generates blocks of luminance image data by transposing pixels on a boundary of a first block of luminance pixel data with boundary pixels of a plurality of blocks of luminance pixel data neighboring said first block of luminance pixel data, and also generates blocks of chrominance image data by transposing pixels on a boundary of a first block of chrominance pixel data with boundary pixels of a plurality of blocks of chrominance pixel data neighboring said first block of chrominance pixel data; and

an image block conversion circuit that generates blocks of image data from blocks of luminance image data and blocks of chrominance image data.

62. The video decoder of claim 61, wherein the pixel transposition circuit transposes alternate pixels along a boundary of the first block of luminance pixel data with pixels from the neighboring blocks of luminance pixel data adjacent to the alternate pixels in a transposition direction.

63. The video decoder of claim 62, wherein the transposition direction is a diagonal direction, high-left to low-right.

64. The video decoder of claim 62, wherein the transposition direction is a diagonal direction, low-left to high-right.

65. The video decoder of claim 62, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first block of luminance pixel data and a horizontal direction for pixels along a horizontal edge of the first block of luminance pixel data.

66. The video decoder of claim 61, wherein the pixel transposition circuit transposes alternate pixels along a boundary of the first block of chrominance pixel data with pixels from the neighboring blocks of chrominance pixel data adjacent to the alternate pixels in a transposition direction.

67. The video decoder of claim 66, wherein the transposition direction is a diagonal direction, high-left to low-right.

68. The video decoder of claim 66, wherein the transposition direction is a diagonal direction, low-left to high-right.

69. The video decoder of claim 66, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first block of chrominance pixel data and a horizontal direction for pixels along a horizontal edge of the first block of chrominance pixel data.

70. A bitstream generated by a process comprising the steps of:

  receiving blocks of image data, each block including an array of pixels;

  converting each block of image data into blocks of luminance pixel data and chrominance pixel data;

  transposing selected pixels on a boundary edge of a first block of luminance pixel data with selected pixels from blocks neighboring the first block of luminance pixel data;

  transposing selected pixels on a boundary edge of a first block of chrominance pixel data with selected pixels from blocks neighboring the first block of chrominance pixel data;

  transforming pixel data of the transposed luminance blocks to luminance coefficients;

  transforming pixel data of the transposed chrominance blocks to chrominance coefficients; and

  scaling the transformed luminance coefficients and the transformed chrominance coefficients.

71. The bitstream of claim 70, wherein the luminance transposition step includes transposing alternate pixels

along a boundary of the first block of luminance pixel data with pixels from the neighboring blocks adjacent to the alternate pixels in a transposition direction.

72. The bitstream of claim 71, further comprising a step of generating a transposition keyword representative of the transposition direction and transmitting the scaled luminance coefficient and the transposition keyword to a channel.

73. The bitstream of claim 71, wherein the transposition direction is a diagonal direction, high-left to low-right.

74. The bitstream of claim 71, wherein the transposition direction is a diagonal direction, low-left to high-right.

75. The bitstream of claim 71, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first block of luminance pixel data and a horizontal direction for pixels along a horizontal edge of the first block of luminance pixel data.

76. The bitstream of claim 70, wherein the chrominance transposition step includes transposing alternate pixels along a boundary of the first block of chrominance pixel data with pixels from the neighboring blocks adjacent to the alternate pixels in a transposition direction.

77. The bitstream of claim 76, further comprising a step of generating a transposition keyword representative of the transposition direction and transmitting the scaled chrominance coefficient and the transposition keyword to a channel.

78. The bitstream of claim 76, wherein the transposition direction is a diagonal direction, high-left to low-right.

79. The bitstream of claim 76, wherein the transposition direction is a diagonal direction, low-left to high-right.

80. The bitstream of claim 76, wherein the transposition direction is a vertical direction for pixels along a vertical edge of the first block of chrominance pixel data and a horizontal direction for pixels along a horizontal edge of the first block of chrominance pixel data.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO.   : RE 41,095 E   Page 1 of 1
APPLICATION NO. : 10/124385
DATED   : February 2, 2010
INVENTOR(S)   : Barin Geoffry Haskell et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:
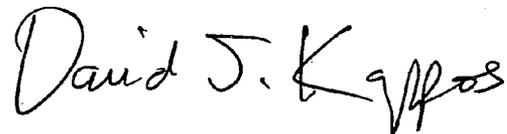
Title Page item 54 and Col. 1

Location of Error: Title of the Invention:

Correct reading of the title:

   --Video Coder Employing Pixel Transposition--

Signed and Sealed this

Sixteenth Day of November, 2010

David J. Kappos
Director of the United States Patent and Trademark Office