

DESCRIPTION

AN IMAGE DECODING METHOD AND AN
IMAGE DECODING APPARATUS

10 Technical Field

The present invention relates to an image coding apparatus and an image decoding apparatus for coding and decoding digital images and also relates to recording
15 media in which image coding/decoding programs are stored.

Background Art

20 One of known conventional image coding systems requiring reversibility is the MMR (Modified Modified Read) system which is used in facsimile applications. However, since the MMR a system is a system in which processing is performed for the entire one frame input,
25 it is difficult to maintain consistency with another coding system adopted in ITU-T H.261 and ISO/IEC MPEG, etc. in which one frame is divided into a plurality of blocks and processing is performed in block units. Thus the MMMR (Modified MMR) that is an improved version of
30 the MMR system is adopted as an verification model of MPEG4 (ISO/IECJTC/SC29/WG11 N1277, July 1996).

An image coding system which divides a one-frame image into two-dimensional blocks consisting of a
35 plurality of pixels and codes the image for each block. Performs coding by diving data into two parts: one is

5 coding mode data which indicates whether or not block
movement is corrected for each block, presence or absence
of a quadrature conversion coefficient and whether or not
a block has significance in the case that the input image
is a form images which indicates the form ad synthesis
10 ratio of the objects, etc., and the method for coding
pixel values within the block, and the other is coding
data of the pixel values within the block.

However, the coding method that performs coding by
15 diving the above image block into the coding mode data
that indicates the coding made of said block and the data
concerning the pixel values within said block has the
problem that the percentage of the lock mode data in the
created coded signal relatively increases, deteriorating
20 its coding efficiency in the case that blocks without
movement information, quadrature conversation coefficient
or significant form, etc, increases with one frame.

25 Disclosure of Invention

The objective of the present invention is to provide
an image coding apparatus and image decoding apparatus
that will prevent the coding efficiency form drastically
30 deteriorating even for those images that contain numerous
blocks without movement information, quarature conversion
coefficient or significant form, etc within one frame.

The image coding apparatus of the invention is an
35 image decoding apparatus, comprising mode decoding means
for decoding codewords indicating the coding mode of

5 pixel block to be decoded using a coding table which assigns a codeword to each coding mode; switching means for switching said codeword table according to a coding mode predicted from the coding modes of blocks peripheral to said pixel block to be decoded; pixel value decoding
10 means for decoding a pixel value of said pixel block to be decoded based on the coding mode decoded for the relevant pixel block.

The image decoding apparatus may be such that the
15 said switching means has a prediction table which provides the correspondence between a combination of a plurality of coding modes and a codeword table which assigns a codeword to each coding mode; said codeword table provides a relatively short codeword length for
20 those coding modes numerically dominant among a plurality of coding modes forming combinations of said coding modes.

An image decoding apparatus, comprising mode
25 decoding means for decoding codewords for the coding data items of pixel blocks to be decoded in quantity corresponding to a plurality of pixel blocks included in the area to be decoded collectively; pixel value decoding means for decoding pixel values of the pixel block to be
30 decoded based on the coding mode decoded for the relevant pixel block.

The image decoding apparatus may be such that said mode decoding means has a codeword table which assigns a
35 codeword to each of a plurality of arbitrary combinations of coding modes and sets a relatively short codeword

5 length for those codewords containing numerous mode combinations of the same modes.

An image decoding apparatus, comprising mode decoding means for arithmetically decoding coding modes
10 of the pixel blocks to be decoded using a probability model which assigns a determined appearance probability to each coding mode; switching means for switching said probability model according to the coding mode predicted from the coding modes of blocks peripheral to said pixel
15 block to be decoded; pixel value decoding means for decoding the pixel values of said pixel block in the coding mode decoded for said pixel blocks.

The image decoding apparatus may be such that said
20 switching means has a prediction model table which provides the correspondence between a combination of a plurality of coding modes and a probability model which assigns an appearance probability to each coding mode; said probability model provides relatively high
25 appearance probability for those coding modes numerically dominant among a plurality of coding modes forming combinations of said coding modes.

A computer program product, comprising a computer
30 readable medium; first program instruction means for instructing a computer processor to decode the codeword indicating the coding mode of a pixel block to be decoded using a coding table which assigns a codeword to each coding mode; second program instruction means for
35 instructing a computer processor to switch said codeword table according to a coding mode predicted from the

5 coding modes of blocks peripheral to said pixel blocks to be decoded; third program instruction means for instructing a computer processor to decode the pixel values of said pixel block to be decoded based on the coding mode decoded for said pixel block; and wherein
10 each program instruction means is stored in said medium in executable form and loaded to a computer memory when executed by the associated processor to operate the computer.

15 A computer program product, comprising a computer readable medium; first program instruction means for instructing the computer processor to arithmetically decode the coding mode of a pixel block to be decoded using a probability model which assigns an appearance
20 probability to each coding mode; second program instruction means for instructing a computer processor to switch said probability model according to the coding mode predicted from the coding modes of blocks peripheral to said pixel block to be decoded; third program
25 instruction means for instructing a computer processor to decode the pixel values of said pixel block to be decoded based on the coding mode decoded for said pixel block; and wherein each program instruction means is stored in said medium in executable form and loaded to computer
30 memory when executed by the associated processor to operate the computer.

An image decoding method, comprising the steps of decoding the codeword indicating the coding mode of a
35 pixel block to be decoded using a coding table which assigns a codeword to each coding mode; switching said

5 codeword table according to the coding mode predicted
from the coding modes of blocks peripheral to said pixel
block to be decode; and decoding the pixel values of said
pixel block to be decoded based on the coding mode
decoded for the relevant pixel block.

10

 An image decoding method, comprising the steps of
decoding the codeword for the coding data of pixel block
to be decoded in quantity corresponding to a plurality of
pixel blocks included in the area to be decoded
15 collectively; and decoding the pixel values of said pixel
block to be decoded based on the coding mode decoded for
the relevant pixel block.

 An image decoding method, comprising the steps of
20 arithmetically decoding the coding mode of a pixel block
to be decoded using probability model which assigns an
appearance probability to each coding mode; switching
said probability model according to the coding mode
predicted from the coding modes of blocks peripheral to
said pixel block to be decoded; and decoding the pixel
25 values of said pixel block to be decoded in the coding
mode decoded for the relevant pixel block.

Brief Description of Drawings

FIG.1 is a block diagram of the image coding system that relates to the first embodiment of the present invention;

FIG.2 is a functional block diagram of the mode data coding section provided in the image coding system in the first embodiment;

FIG.3 is a configuration diagram of the code word table prediction table contained in the mode data coding section;

FIG.4 is a diagram showing how a frame image is divided into sections;

FIG.5 is a diagram showing the coding modes of a block to be coded and peripheral blocks;

FIG.6 is a diagram showing the pixel value status of each block in one frame;

FIG.7A is a diagram showing code words when the blocks shown in FIG.6 are image-coded according to the present invention;

FIG.7B is a diagram showing code words when the blocks shown in FIG.6 are image-coded according to a general coding system;

FIG.8 is a block diagram of the image decoding system of the second embodiment of the present invention;

FIG.9 is a functional block diagram of the mode data decoding section provided in the image decoding system in the second embodiment;

FIG.10 is a block diagram of the image coding system

of the third embodiment of the present invention;

FIG.11 is a configuration diagram of the code word table provided for the image coding system in the third embodiment;

5 FIG.12 is a diagram showing an example of the pixel value status of each block with respect to an image to be coded;

FIG.13A is a diagram showing code words when the block in FIG.12 is image-coded according to the present
10 invention;

FIG.13B is a diagram showing code words when the block in FIG.12 is image-coded according to a general coding system;

FIG.14 is block diagram of the image decoding system
15 that relates to the fourth embodiment of the present invention;

FIG.15 is a conceptual diagram of the arithmetic coding method;

FIG.16 is a configuration diagram of the appearance
20 probability table used in the fifth embodiment of the present invention;

FIG.17 is a schematic view of the recording medium that stores the image coding/decoding program that relates to the sixth embodiment of the present invention,
25 and

FIG.18 is a schematic diagram of the network that distributes the image coding/decoding program of the

present invention.

Best Mode for Carrying out the Invention

With reference now to the attached drawings, the
5 embodiments of the present invention are explained in
detail below:

(First embodiment)

FIG.1 shows a block diagram of the image coding
system that constitutes the first embodiment of the
10 present invention. The image coding system shown in said
figure comprises coding mode judgment section 1 that
outputs the coding mode data which indicates the coding
mode of a pixel block to be coded, mode data coding section
2 that generates mode data code words using a code word
15 table which will be described later, block data coding
section 3 that generates a code word for the pixel value
within the pixel block, and multiplexing section 4 that
generates a coded image signal by multiplexing the code
word regarding the mode data and the code word regarding
20 the pixel value data. Here, code 11 indicates a pixel
value signal of a block of a digital input image divided
by the block division block which is not shown in the
figure; code 12 indicates the coding mode data of the
pixel block; code 13 indicates the code word regarding
25 the mode data; code 14 indicates the code word regarding
the block data; code 15 indicates a coded image signal
of the digital input image divided into blocks.

FIG.2 shows the functional block configuration of mode data coding section 2. As shown in FIG.2, mode data coding section 2 comprises mode data storage section 21 that stores coding mode data, mode data read section 22 that reads coding mode data of blocks peripheral to the block to be coded, code word table prediction table 23 consisting of a plurality of code word tables, code word table selection section 24 that selects the optimal code word table; and coding section 25 that codes mode data based on the code word table.

FIG.3 shows an actual example of code word table prediction table 23. It is designed that the coding efficiency may be improved by adjusting a combination of the mode data of the already coded peripheral blocks and a plurality of code word tables which contain different coding patterns.

The operation of the image coding system configured above is explained below:

Firstly, the digital input image, as shown in FIG.4, constitutes form information that indicates the form or the ratio of synthesis of a normal color signal or object wherein one frame is configured from horizontal M pixels and vertical N lines. The one-frame digital input image is divided into a plurality of pixel blocks made up of horizontal m pixels and vertical n lines by the block division block which is not shown in the figure. Pixel value signal 11 of the resulting pixel blocks is input

to coding mode judgment section 1 and block data coding section 3.

Coding mode judgment section 1 determines the coding mode of that pixel block from the pixel value data of the pixel block at position (i,j) (hereafter described as POS (i,j)). In the case of a normal color signal, the presence or absence of movement correction and the presence or absence of quadrature conversion coefficient are determined, and in the case of a form signal, the presence or absence of a significant form is determined. In the case of a binary image signal, there can be three statuses: (A) all pixels in the block are black pixels; (B) all pixels are white pixels; (C) black pixels and white pixels are mixed. Therefore, there are three coding modes A, B, and C corresponding to three statuses, respectively. The coding mode of the pixel block at POS (i,j) is described hereafter as MODE (i,j) . Coding mode judgment section 1 outputs determined MODE (i,j) to mode data coding section 2 and block data coding section 3.

Mode data coding section 2 selects the code word table corresponding to MODE (i,j) from the code word table prediction table shown in FIG.3 to generate a code word regarding the mode data.

The method of coding the mode data is explained in detail below:

In mode data coding section 2, supposing that the coding mode of the pixel block now to be coded is MODE

(i,j), it is possible to predict MODE (i,j) from coding modes MODE (i-1,j), MODE (i-1,j-1) and MODE (i,j-1) of the already coded pixel blocks (POS (i-1,j-1), POS (i,j-1), POS (i-1,j)) peripheral to the pixel block at
5 POS (i,j) as shown in FIG.5.

That is, when there are three coding modes A, B, and C, in the case that MODE (i-1,j), MODE (i-1,j-1), and MODE (i,j-1) are all A, there is a high probability that MODE (i,j) will also be A.

10 In typical conventional mode data coding, a specific code word is provided for each of coding modes A, B and C and a code word is assigned according to the coding mode determined. That is, only one set of the code word of coding mode A, code word of coding mode B and
15 code word of coding mode C is prepared beforehand (code word table) and the code word for the corresponding coding mode is extracted and output. In addition to that, the length of each code word is fixed at the same length (number of bits).

20 As shown in FIG.3, in the present invention, a plurality of code word tables are provided in the code word table prediction table and some specific code word tables include code words of a short code word length. In the case that the coding mode of blocks peripheral
25 to the block to be coded is inclined toward a specific mode, there is a high probability of the block to be coded being the same as the specific mode, and thus the code

word of the specific mode is set shorter than the code word of other coding modes.

To be concrete, in the case that the coding mode of the peripheral blocks is inclined toward A, the code word of coding mode A is set to "0" (code word length = 1 bit); the code word of coding mode B is set to "10" (code word length = 2 bits); and the code word of coding mode C is set to "11" (code word length = 2 bits). In the case that numerous B's are included in the coding mode of the peripheral blocks or in the case that numerous C's are included in the coding mode of the peripheral blocks, the code word length of the respective dominant coding modes is set shorter.

Mode data coding section 2 stores the mode data sent from coding mode judgment section 1 in mode data storage section 21 to make it easy to acquire the coding mode information of the blocks peripheral to the block to be coded. The mode data of the pixel block is stored in the position corresponding to said block within one frame.

When block position POS (i,j) of the block to be coded is input, mode data read section 22 reads coding modes MODE (i-1,j), MODE (i-1, j-1), and MODE (i,j-1) at block positions POS (i-1,j-1), POS (i,j-1), POS (i-1,j) from mode data storage section 21 and gives them to code word table selection section 24.

Code word table selection section 24 selects the code word table set in association with a combination

that matches the combination of coding modes $\text{MODE}(i-1, j)$, $\text{MODE}(i-1, j-1)$, and $\text{MODE}(i, j-1)$ of the peripheral blocks from code word table prediction table 23. For example, in the case that the coding modes of the peripheral blocks are (A, A, A) , (A, A, B) , (A, A, C) , (B, A, A) , (C, A, A) , (A, B, A) , or (A, C, A) , the code word table of $(A=0, B=10, C=11)$ is selected. The example above is the case where coding mode A of the peripheral blocks is dominant. In the case that coding mode B of the peripheral blocks is dominant, the code word table of $(A=10, B=0, C=11)$ is selected, and in the case that coding mode C of the peripheral blocks is dominant, the code word table of $(A=10, B=11, C=0)$ is selected. The code word table selected according to the mode statuses of peripheral blocks is given to coding section 25.

Thus, the present invention allows the code word table used for coding of mode data to be switched adaptively according to the coding mode statuses of peripheral blocks.

Coding section 25 codes the mode data of the block to be coded based on the selected code word table. Now, in the case that the coding mode input from coding mode judgment section 1 is A and the code word table input from code word table selection section 24 is $(A=0, B=10, C=11)$, code word = 0 is output.

Therefore, in the case that blocks peripheral to the block to be coded includes a dominant mode and the

mode of the block to be coded matches the dominant mode, a short code word is generated.

Suppose that the coding mode status of each pixel block of a frame image is as shown in FIG.6. If the code word table can be changed adaptively according to the coding mode statuses of peripheral blocks as in the case of the present invention, the code word length of the hatched block in FIG.7A becomes shorter, and thus the coding efficiency can be improved. On the other hand, in the case that a frame image as shown in FIG.6 is coded using the code word table with only one set of (A=0, B=10, C=11) fixed, the coding result will be as shown in FIG.7B. It is observable that the coding efficiency is reduced compared to the code word shown in FIG.7A.

If A or B is input as the coding mode regarding the pixel block at POS (i,j) from coding mode judgment section 1, block data coding section 3 stops coding of the pixel value of the block to be coded. This is because in the case of coding modes A and B, all pixels in the block are black or white and therefore decoding of the pixel block is possible with only the mode data. In the case of coding mode C, the pixel value of the block to be coded is coded and the code word regarding the block data is output.

Multiplexing section 4 multiplexes the code word regarding the mode data with the code word regarding the block data to output a coded image signal.

As seen above, the present embodiment provides a plurality of code word tables to convert individual mode data to a code word in association with the coding mode statuses of peripheral blocks and assigns short code words to a dominant mode prevailing in the peripheral blocks, thus allowing the code word tables to be switched adaptively according to the coding mode statuses of peripheral blocks.

On the other hand, instead of handing over the content of the code word table selected by code word table selection section 24 to coding section 25, it is also possible to notify only the number of the selected code word table to coding section 25 so that coding section 25 may incorporate the content of the code word table specified with a number from code word table prediction table 23.

(Embodiment 2)

FIG.8 is a block diagram of the image decoding system that relates to the second embodiment of the present invention. In said figure, the same signals as those in the first embodiment shown in FIG.1 are assigned the same numbers and their explanations are omitted here.

This image decoding system comprises demultiplexing section 81 that separates the code word regarding the mode data and the code word regarding the block data from the coded image signal, mode data

decoding section 82 that reproduces the coding mode data of the pixel block from the code word regarding the mode data, and block data decoding section 83 that reproduces the pixel value within the pixel block in the mode
5 indicated by the reproduced mode data.

FIG.9 is a functional block diagram of mode data decoding section 82. Mode data decoding section 82, comprises decoding section 91 that decodes the code word of the mode data, mode data storage section 92 that stores
10 the mode data of the decoded pixel block, mode data read section 93 that reads the stored mode data, code word table prediction table 94 that combines the mode statuses of peripheral blocks viewed from the block to be decoded and code word tables, and code word table selection
15 section 95 that selects a code word table.

If the code word of the mode data coded by mode data coding section 2 in the first embodiment is decoded by the image decoding system in the present embodiment, it is necessary to use code word table prediction table 94
20 with the same content as that shown in FIG.3.

The operation of the image decoding system in the second embodiment configured as shown above is now explained below.

Firstly, de-multiplexing section 81 separates
25 coded image signal 15 into code word 13 regarding the mode data and code word 14 regarding the block data. Code word 13 regarding the mode data is input to mode data

decoding section 82, while code word 14 regarding the block data is input to block data decoding section 83.

Upon receiving code word 13 regarding the mode data, mode data decoding section 82 reproduces coding mode data
5 12 of the corresponding block from code word table prediction table 94.

With reference now to FIG.9, the operation of mode data decoding section 82 is explained. After decoding section 91 decodes the code word of mode data, the decoded
10 mode data is written to the corresponding pixel block position of mode data storage section 92.

In mode data read section 93, position information within one frame of the block to be decoded is input. Mode data read section 93 reads the mode data of the
15 decoded blocks peripheral to the block to be decoded from mode data storage section 92 based on the position information of the block to be decoded and inputs it to code word table selection section 95.

Code word table selection section 95 extracts the
20 same code word table as the code word table at the time of coding from code word table prediction table 94 based on the mode data statuses of the blocks peripheral to the block to be decoded. The code word table extracted from code word table prediction table 94 is handed over
25 to decoding section 91.

Decoding section 91 decodes the code word regarding the mode data of the block to be decoded using the code

word table handed over from code word table selection section 95.

For example, supposing that the block to be decoded by mode data decoding section 82 is a block at POS (i,j),
5 MODE (i-1,j), MODE (i-1,j-1), and MODE (i,j-1) shown in FIG.5 have already been reproduced, and it is possible to correctly reproduce the coding mode of the block MODE (i,j) from the code word regarding the mode data coded in the first embodiment by switching the code word table
10 from the statuses of modes MODE (i-1,j), MODE (i-1,j-1), and MODE (i,j-1) according to FIG.3.

The decoded mode data is stored in mode data storage section 92 and at the same time input to block data decoding section 83.

15 Block data decoding section 83 receives code word 14 regarding the block data and reproduces digital pixel value signal 31 within the block and outputs it by performing decoding processing corresponding to the coding mode shown in coding mode data 12.

20 In the first and second embodiments above, the mode data of three peripheral blocks was used to predict the mode data of the block to be coded, but it is also possible to increase the number of reference blocks.

The embodiment above describes the case where there
25 are 3 kinds (A, B, C) of mode data, but it is also possible to apply the similar processing to more statuses.

Combining the image coding system in the first

embodiment and the image decoding system in the second embodiment will allow a coding/decoding system to be implemented.

5 (Third embodiment)

FIG.10 shows a block diagram of the image coding system that relates to a third embodiment of the present invention. In said figure, the same functional blocks and same signals as those of the system shown in FIG.1
10 are assigned the same numbers and their explanations are omitted.

The image coding system in the present embodiment comprises coding mode judgment section 1, memory 101 that stores coding mode data output from coding mode judgment
15 section 1 for each block and outputs one-frame data together, mode data coding section 102 that codes one-frame coding mode data together to create code words, block data coding section 3, memory 103 that stores the code word regarding the block data for each block and
20 outputs one-frame data together, and multiplexing section 104 that multiplexes the code word regarding one-frame mode data with the code word regarding the block data of each pixel block within the same frame to generate a coded image signal. Code 111 indicates
25 one-frame coding mode data; 112, the code word regarding one-frame mode data; 113, the code word regarding one-frame block data; and 114, the coded image signal

of a digital input image.

The operation of the image coding system in the present embodiment configured above is explained below:

Firstly, for digital input image signal 11, coding
 5 mode MODE (i,j) of the block at POS (i,j) is determined
 by coding mode judgment section 1 as in the case of the
 first embodiment. The determined MODE (i,j) is stored
 in memory 101. When mode data MODE (1,1), MODE (1,2), ...
 MODE (2,1), ... MODE (X,Y) of all the pixel blocks
 10 corresponding to one frame are stored, all the mode data
 is transferred to mode data coding section 102 at a time.

Mode data coding section 102 codes one-frame mode
 data using the code word table shown in FIG.11. The coding
 operation of mode data coding section 102 is explained
 15 in detail below.

Mode data coding section 102 has a code word table
 (shown in FIG.11) to encode mode data of a plurality of
 blocks collectively. In this code word table, a specific
 code word is assigned to each of all pairs of 3 kinds
 20 of mode (A, B, C). Especially for combinations of the
 same modes (A,A) (B,B), and (C,C), the code word length
 is designed to be relatively shorter than other
 combinations.

Now, suppose that one-frame mode data with the
 25 content as shown in FIG.12 is transferred to mode data
 coding section 102.

Mode data is sequentially extracted from the start

of the line 2 blocks at a time. In the case of FIG.12, mode data will be coded two consecutive data items in horizontal direction at a time in order of (A,B), (B,B), and (A,A).

5 FIG.13A shows the result of coding the one-frame mode data shown in FIG.12 using the code word table shown in FIG.11. It is observable that the area where one combination of the same modes appears after another contains short code words. FIG.13B shows the result of
10 coding the one-frame mode data shown in FIG.12 using a fixed code word table such as A=0, B=10, C=1 as in the case of the previous comparison example. As clearly seen from a comparison of FIG.13A and FIG.13B, the number of bits of the code word of one-frame mode data in the coding
15 system of the present invention is less than that in conventional coding systems.

Mode data code word 112 coded in this way is given to multiplexing section 104.

On the other hand, the pixel data of the pixel block
20 is coded by block data coding section 3 as in the case of the first embodiment, and the code word regarding the block data is stored in memory 103 and organized into code word 113 regarding the block data corresponding to the entire one frame.

25 Then, multiplexing section 104 multiplexes code word 112 regarding the mode data and code word 113 regarding the block data of the entire one frame and

outputs coded image signal 114.

Thus, the third embodiment stores the mode data of one-frame pixel block in memory before coding a plurality of mode data items collectively. In the code word table
5 to encode a plurality of mode data items collectively, shorter code words are set for combinations of the same mode data.

(Fourth embodiment)

10 FIG.14 is a block diagram of the image decoding system that relates to a fourth embodiment of the present invention. In said figure, the same signals as those shown in FIG.1 and FIG.8 are assigned the same numbers and their explanations are omitted.

15 The image decoding system of the present embodiment comprises de-multiplexing section 141 that separates a code word string regarding the mode data and a code word string regarding the block data from a coded signal, mode data decoding section 142 that obtains mode data from
20 a code word string regarding the mode data, memory 143 that stores mode data of all blocks corresponding to one frame, and block data decoding section 83 that reproduces pixel values from a code word string regarding the block data.

25 Mode data decoding section 142 has a code word table shown in FIG.11 to decode the code word of the mode data coded by the image coding system in the third embodiment.

Mode data decoding section 142 decodes the code word of the mode data using the code word table in FIG.11.

The operation of the image decoding systems in the fourth embodiment configured above is explained below:

5 Firstly, de-multiplexing section 141 receives coded signal 114, separates and outputs coded signal 114 to the code word string regarding the mode data of all blocks corresponding to one frame and the code word string regarding the block data of each block.

10 Mode data decoding section 142 decodes the code word of the mode data into mode data of two pixel blocks using the code word table in FIG.11 in a procedure opposite to the coding procedure in the third embodiment. Mode data 111 decoded by mode data decoding section 142 is

15 stored in memory 143 and its one-frame data is output together to block data decoding section 83.

The mode data of all blocks within one frame decoded by mode data decoding section 142 is stored in memory 143 and mode data $MODE(i,j)$ of the block to be reproduced

20 is given to block data decoding section 83 in accordance with a request from block data decoding section 83.

Lastly, block data decoding section 83 receives code word string 14 regarding the block data of the block at position $POS(i,j)$ separated and output by de-

25 multiplexing section 141 and mode data $MODE(i,j)$ of the block output from memory 143 and reproduces and outputs pixel values in the block in accordance with $MODE(i,j)$.

Furthermore, an appropriate sorting block which is not shown in the figure reproduces the digital image signal by sorting the pixel values for each block output in the scanning order.

5 In the third and fourth embodiments above, mode data items of two continuous pixel blocks were coded together, but it is also possible to encode mode data items of numerous pixel blocks together. Further, a plurality of continuous pixel blocks in horizontal direction are
10 coded, but it is also possible to encode a plurality of continuous pixel blocks in vertical direction or continuous pixel blocks in two-dimensional directions together. This requires a code word table corresponding to the combination of blocks to be coded together.

15

(Fifth embodiment)

The first to fourth embodiments above describe coding of mode data using the code word table shown in FIG.3 or FIG.4, but it is also possible to use other coding
20 techniques such as arithmetic coding technique.

In the image coding/decoding system that relates to a fifth embodiment, a mode data coding section/mode data decoding section performs coding/decoding using an arithmetic coding technique and switches probability
25 models used for arithmetic coding/decoding by predicted values of the mode data of the block to be coded/decoded. The configuration except the mode data coding

section/mode data decoding section is the same as the above-mentioned embodiments.

In arithmetic coding, the data series to be coded is mapped on a probability number line divided according to the appearance probability of dominant symbols and inferior symbols and their positions are expressed in binary point values and output as code series.

FIG.15 shows a conceptual diagram of arithmetic coding.

This figure presents a case where data series $S = \{010011\dots\}$ is coded with "P" indicating the appearance probability of "0" and "Q" indicating the appearance probability of "1". The position of "C" on the probability number line indicates the code corresponding to data string "S". In such coding, code "C" is determined by the following coding rules.

<Coding rules>

When data is 0 (dominant symbol)

$C \leftarrow C + A * Q$

$A \leftarrow A * P$

When data is 1 (inferior symbol)

$A \leftarrow A * Q$

"A" is an which indicates the range of the existence of codes and corresponds to the hatching area in FIG.15.

Appearance probabilities P and Q are the

probability models and correspond to the code word tables. A conventional arithmetic coding technique often uses fixed probability models. If three kinds of data items A, B, and C are coded/decoded as shown in the embodiment
5 above, three types of appearance probability are also required.

The present embodiment performs arithmetic coding/decoding using a probability model table in which a plurality of probability models (No1 to No3) are set
10 as shown in FIG.16. The probability model table is a table showing the correspondence between a combination of modes of a plurality of pixel blocks and probability model as in the case of the code word table prediction table shown in FIG.3. The combination of modes is the
15 same as that shown in FIG.3 and is not illustrated here, but the model number corresponds to the combination of modes. Appearance probability of each mode making up the probability model is set in such a way that if there are numerous specific modes in the peripheral blocks, the
20 appearance probability for those modes is relatively high.

When a fixed probability model is used, the code word length of inferior symbols becomes longer, and therefore in the case that an image that contains
25 numerous inferior symbols is coded, the coding efficiency is reduced.

The present embodiment predicts the mode of the

block to be coded from the modes of peripheral blocks and performs coding using a probability model with the appearance probability of the predicted mode set higher, making it possible to improve the coding efficiency.

5

(Sixth embodiment)

The present invention implements the configurations shown in the first to fifth embodiments by software or programming and allowing another
10 independent computer system to easily implement them by transferring them recorded in a recording medium such as a floppy disk.

If a computer system incorporates a function equivalent to coding mode judgment section 1, a function
15 equivalent to block data coding section 3, a function equivalent to multiplexing sections 4 and 104 and an existing mode data coding function, it is also possible to replace the program implementing mode data coding sections 2 and 102 by another program implementing an
20 existing mode data coding function. In this case, only the program implementing mode data coding sections 2 and 102 or the program implementing program replacement processing is stored in a recording medium and carried.

FIG.17 shows a floppy disk as an example of
25 recording medium.

In this embodiment, a floppy disk is shown as a recording medium, but any IC card, CD-ROM, magnet tape

and whatever capable of recording the program can be used likewise.

Furthermore, as a method of downloading the program above to a computer system, it is also possible to
5 download the program from a server device to a terminal device via the Internet or other communication network as shown in FIG.18.

The present invention is not limited only to the above mentioned embodiments, but can be modified in
10 various ways as long as they are not deviated from the purpose of the present invention and those are included in the range of the present invention.

Industrial Applicability

15 As described above, the present invention is useful for image coding systems or image decoding systems which perform coding or decoding by dividing a digital image into blocks and separating block coding mode and block data for each block, and suited to improving the coding
20 efficiency of code words regarding to the coding mode and coding the input images with fewer bits.



5

CLAIMS

1. An image decoding apparatus, comprising:
mode decoding means for decoding codewords indicating
the coding mode of pixel block to be decoded using a coding
10 table which assigns a codeword to each coding mode;
switching means for switching said codeword table
according to a coding mode predicted from the coding modes
of blocks peripheral to said pixel block to be decoded;
pixel value decoding means for decoding a pixel value
15 of said pixel block to be decoded based on the coding mode
decoded for the relevant pixel block.
2. The image decoding apparatus according to claim 1,
wherein:
said switching means has a prediction table which
20 provides the correspondence between a combination of a
plurality of coding modes and a codeword table which assigns
a codeword to each coding mode;
said codeword table provides a relatively short
codeword length for those coding modes numerically dominant
25 among a plurality of coding modes forming combinations of
said coding modes.
3. An image decoding apparatus, comprising;
mode decoding means for decoding codewords for the
coding data items of pixel blocks to be decoded in quantity
30 corresponding to a plurality of pixel blocks included in the
area to be decoded collectively;
pixel value decoding means for decoding pixel values
of the pixel block to be decoded based on the coding mode
decoded for the relevant pixel block.
- 35 4. The image decoding apparatus according to claim 3,
wherein:
said mode decoding means has a codeword table which



5 assigns a codeword to each of a plurality of arbitrary combinations of coding modes and sets a relatively short codeword length for those codewords containing numerous mode combinations of the same modes.

5. An image decoding apparatus, comprising:

10 mode decoding means for arithmetically decoding coding modes of the pixel blocks to be decoded using a probability model which assigns a determined appearance probability to each coding mode;

switching means for switching said probability model
15 according to the coding mode predicted from the coding modes of blocks peripheral to said pixel block to be decoded;

pixel value decoding means for decoding the pixel values of said pixel block in the coding mode decoded for said pixel blocks.

20 6. The image decoding apparatus according to claim 5, wherein:

said switching means has a prediction model table which provides the correspondence between a combination of a plurality of coding modes and a probability model which
25 assigns an appearance probability to each coding mode;

said probability model provides relatively high appearance probability for those coding modes numerically dominant among a plurality of coding modes forming combinations of said coding modes.

30 7. A computer program product, comprising:

a computer readable medium;

first program instruction means for instructing a computer processor to decode the codeword indicating the coding mode of a pixel block to be decoded using a coding
35 table which assigns a codeword to each coding mode;

second program instruction means for instructing a computer processor to switch said codeword table according



5 to a coding mode predicted from the coding modes of blocks peripheral to said pixel blocks to be decoded;

third program instruction means for instructing a computer processor to decode the pixel values of said pixel block to be decoded based on the coding mode decoded for
10 said pixel block; and

wherein each program instruction means is stored in said medium in executable form and loaded to a computer memory when executed by the associated processor to operate the computer.

15 8. A computer program product, comprising:

a computer readable medium;

first program instruction means for instructing the computer processor to arithmetically decode the coding mode of a pixel block to be decoded using a probability model
20 which assigns an appearance probability to each coding mode;

second program instruction means for instructing a computer processor to switch said probability model according to the coding mode predicted from the coding modes of blocks peripheral to said pixel block to be decoded;

25 third program instruction means for instructing a computer processor to decode the pixel values of said pixel block to be decoded based on the coding mode decoded for said pixel block; and

wherein each program instruction means is stored in
30 said medium in executable form and loaded to computer memory when executed by the associated processor to operate the computer.

9. An image decoding method, comprising the steps of;

(a) decoding the codeword indicating the coding mode
35 of a pixel block to be decoded using a coding table which assigns a codeword to each coding mode;

(b) switching said codeword table according to the



- 5 coding mode predicted from the coding modes of blocks
peripheral to said pixel block to be decode;
and
(c) decoding the pixel values of said pixel block to
be decoded based on the coding mode decoded for the relevant
10 pixel block.
10. An image decoding method, comprising the steps of:
(a) decoding the codeword for the coding data of
pixel block to be decoded in quantity corresponding to a
plurality of pixel blocks included in the area to be decoded
15 collectively;
and
(b) decoding the pixel values of said pixel block to
be decoded based on the coding mode decoded for the relevant
pixel block.
- 20 11. An image decoding method, comprising the steps of:
(a) arithmetically decoding the coding mode of a
pixel block to be decoded using probability model which
assigns an appearance probability to each coding mode;
(b) switching said probability model according to
25 the coding mode predicted from the coding modes of blocks
peripheral to said pixel block to be decoded;
and
(c) decoding the pixel values of said pixel block to
be decoded in the coding mode decoded for the relevant pixel
30 block.