(54) Title: APPARATUS FOR CHANNEL ENCODING FOR ENHANCEMENT LAYER OF DIGITAL MULTIMEDIA BROAD-CASTING TRANSMITTER, DIGITAL MULTIMEDIA BROADCASTING TRANSMITTER SYSTEM, DIGITAL MULTIME-DIA BROADCASTING RECEIVING SYSTEM AND EXPANSION-FORM OF FIG 0/1

[FIG. 3]

(57) Abstract: The present invention relates to a channel encoder for an enhancement layer of a digital-multimedia-broadcasting transmitting device, a digital broadcasting transmitting device, a digital broadcasting receiving device, and an extension structure of sub-channel configuration field (FIG0/1) for designating a protection level of sub-channel at the enhancement layer. In a channel encoder for the enhancement layer according to the invention, the channel encoder is included in a hierarchical DMB transmitting unit that modulates a base layer transport stream and a enhancement layer transport stream for video and audio by a base layer modulation system and an enhancement layer modulation system, respectively, and performs symbol mapping of the enhancement layer according to the position of a constellation based on the base layer modulation system. Furthermore, the hierarchical DMB transmitting unit includes an energy dispersal scrambler that disperses energy of the enhancement layer transport stream, and a turbo encoder that receives a double-binary input vector corresponding to an output of the energy dispersal scrambler and encodes it by using a double-binary circular recursive systematic code.

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【Invention Title】

APPARATUS FOR CHANNEL ENCODING FOR ENHANCEMENT LAYER OF DIGITAL MULTIMEDIA BROADCASTING TRANSMITTER, DIGITAL MULTIMEDIA BROADCASTING TRANSMITTER SYSTEM, DIGITAL MULTIMEDIA BROADCASTING RECEIVING SYSTEM AND EXPANSION-FORM OF FIG 0/1
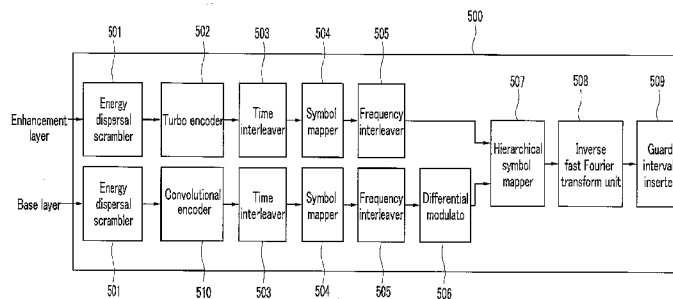
【Technical Field】

The present invention relates to a channel encoder for an enhancement layer of a digital-multimedia-broadcasting transmitting device, a digital broadcasting transmitting device, a digital broadcasting receiving device, and an extension structure of sub-channel configuration field (FIG 0/1) for designating a protection level of sub-channel at the enhancement layer.

The present invention is derived from research that is performed as part of IT New Growth Engine Industries of the Ministry of Information and Communication and Institute for Information Technology Advancement, Republic of Korea [Project-Management Number: 2006-S-017-02, Project Title: Development on Enhancement Technology of Terrestrial DMB transport].

【Background Art】

A conventional digital-multimedia-broadcasting transmitting device performs source encoding of video and audio sources, removes temporal correlation between adjacent byte units in data streams by executing objectification and synchronization of each stream, receives the streams to be output through a stream mode channel by using a digital audio broadcasting

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(hereinafter referred to as DAB) transmitting unit, transforms the received streams into final digital broadcasting signals, and outputs the final digital broadcasting signals.

An example of the DAB transmitting unit includes a Eureka-147 DAB

5   system, which is a European digital audio broadcasting system.   In the Eureka-147 DAB system, when a convolutional coding process having a 1/2 coding rate is applied, an available data rate is 1.152 Mbps.   When two video services are applied to one channel, a data rate of 576 kbps is allocated to each service.

10   Accordingly,   this   conventional   digital-multimedia-broadcasting transmitting device has a limitation in providing a high-quality service, even though highly efficient source encoding is applied.

The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and therefore

15   it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

【DETAILED DESCRIPTION】

【Technical Object】

The present invention is to provide a channel encoder for an

20   enhancement layer of a digital-multimedia-broadcasting transmitting device, a digital broadcasting transmitting device, a digital broadcasting receiving device, and an extension structure of sub-channel configuration field (FIG0/1) for designating a protection level of sub-channel at the enhancement layer.

【Technical Solution】

According to an aspect of the invention, a channel encoder for the enhancement layer of a digital-multimedia-broadcasting transmitting device is provided. In a channel encoder for an enhancement layer, the channel encoder

5 is included in a hierarchical DMB transmitting unit that modulates a base layer transport stream and a enhancement layer transport stream for video and audio by a base layer modulation system and an enhancement layer modulation system, respectively, and performs symbol mapping of the enhancement layer according to the position of a constellation based on the base layer modulation

10 system. Furthermore, the hierarchical DMB transmitting unit includes an energy dispersal scrambler that disperses energy of the enhancement layer transport stream, and a turbo encoder that receives a double-binary input vector corresponding to an output of the energy dispersal scrambler and encodes it by using a double-binary circular recursive systematic code.

15 According to another aspect of the invention, a digital-multimedia-broadcasting transmitting device is provided. The digital-multimedia-broadcasting transmitting device includes: a base layer transmission processing unit that receives a base layer stream, performs system encoding and multiplexing of the received the base layer stream, and outputs a

20 base layer transport stream; an enhancement layer transmission processing unit that receives an enhancement layer stream, performs system encoding and multiplexing of the received enhancement layer stream, and outputs an enhancement layer transport stream; and a hierarchical

digital-multimedia-broadcasting transmitting unit that modulates the base layer transport stream by a base layer modulation system, modulates the enhancement layer transport stream by a different system from the base layer modulation system, and performs symbol mapping of an enhancement layer

5   according to the position of a constellation based on the base layer modulation system.

According   to   still   another   of   the   invention,   a digital-multimedia-broadcasting   receiving   device   is   provided.   The digital-multimedia-broadcasting   receiving   device   includes: a   hierarchical

10   digital-multimedia-broadcasting   receiver   that   receives   a   digital   multimedia broadcasting signal and outputs it by dividing the received signal into a base layer transport stream and an enhancement layer transport stream; a base layer receiving processor that performs channel decoding of the base layer stream, de-multiplexes a transport stream, performs system decoding, and outputs a

15   base layer audio and video stream; and an enhancement layer receiving processor that performs turbo decoding of the enhancement layer stream, de-multiplexes a transport stream, performs system decoding, and outputs an enhancement layer audio and video stream. According to still another of the invention, an extension structure of a sub-channel configuration field (FIG 0/1) in

20   a digital-multimedia-broadcasting transmitting device is provided.

In a structure of a sub-channel configuration field (FIG 0/1) in a digital-multimedia-broadcasting transmitting device that modulates a base layer transport stream and an enhancement layer transport stream by a base layer

modulation system and an enhancement layer modulation system, respectively, and performs symbol mapping of the enhancement layer according to the position of a constellation based on the base layer modulation system, the extension structure includes: an option field that has a predetermined value for

5   equal error protection of the enhancement layer; and a protection level field that includes protection level information when the value of an option field is a predetermined value.

【Brief Description of the Drawings】

FIG. 1 is a schematic diagram of a digital-multimedia-broadcasting

10   transmitting device according to an exemplary embodiment of the present invention.

FIG. 2 is a schematic diagram of an enhancement-layer transmission processing unit 300 according to the exemplary embodiment of the invention.

FIG. 3 is a schematic diagram of a hierarchical DMB transmitting unit 500

15   according to the exemplary embodiment of the invention.

FIG. 4 is a schematic diagram of a hierarchical DMB transmitting unit 550 according to a second exemplary embodiment of the invention.

FIG. 5 is a schematic diagram of a turbo encoder 502 according to the exemplary embodiment of the invention.

20   FIG. 6 is a view illustrating a configuration of a constituent coding unit 602.

FIG. 7 illustrates a structure of a sub-channel configuration field (FIG 0/1) according to the invention.

FIG. 8 is a schematic diagram of a digital-multimedia-broadcasting receiving device according to the exemplary embodiment of the invention.

FIG. 9 is a detailed schematic diagram of a hierarchical DMB receiving unit of FIG. 8.

5   【Best Mode】

In the following detailed description, only certain exemplary embodiments of the present invention have been shown and described, simply by way of illustration. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing

10   from the spirit or scope of the present invention. Accordingly, the drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements throughout the specification.

Through the specification, unless explicitly described to the contrary, the word "comprise" and variations such as "comprises" or "comprising" will be

15   understood to imply the inclusion of stated elements but not the exclusion of any other elements. In addition, the terms "-er", "-or" and "module" described in the specification mean units for processing at least one function and operation and can be implemented by hardware components or software components and combinations thereof.

20   With reference to the accompanying drawings, a channel encoder for an enhancement layer, a digital-broadcasting transmitting device, a digital-broadcasting receiving device, and an extension structure of the sub-channel configuration field (FIG 0/1) for designating a protection level of

sub-channel at the enhancement layer of a digital-multimedia-broadcasting transmitting device according to an exemplary embodiment of the invention will now described in detail.

FIG. 1 is a schematic diagram of the digital-multimedia-broadcasting

5   transmitting device according to the exemplary embodiment of the invention.

Referring to FIG. 1, the digital-multimedia-broadcasting transmitting device according to the exemplary embodiment of the invention includes an MPEG-4 video encoder 100, an MPEG-4 audio encoder 200, an enhancement layer transmission processing unit 300, a base layer transmission processing

10   unit 400, and a hierarchical DMB transmitting unit 500.   Each component of FIG. 1 will now be described.

The MPEG-4 video encoder 100 encodes video signals of data to be transmitted to the base layer or the enhancement layer and outputs the encoded video signals.

15   The MPEG-4 audio encoder 200 encodes audio signals of data to be transmitted to the base layer or the enhancement layer and outputs the encoded audio signals.

The enhancement layer transmission processing unit 300 receives an enhancement layer stream, which is output from the MPEG-4 video encoder 100

20   and the MPEG-4 audio encoder 200, performs system encoding, multiplexes the encoded enhancement layer stream into a media stream, and outputs an enhancement layer transport stream.

The base layer transmission processing unit 400 receives a base layer

stream, which is output from the MPEG-4 video encoder 100 and the MPEG-4 audio encoder 200, performs system encoding, multiplexes the encoded base layer stream into a transport stream, and outputs a base layer transport stream.

The hierarchical DMB transmitting unit 500 receives the base layer
5 transport stream and the enhancement layer transport stream, which are output from the enhancement layer transmission processing unit 300 and the base layer transmission processing unit 400, respectively. Moreover, the hierarchical DMB transmitting unit 500 modulates the base layer transport stream and the enhancement layer transport stream by a base layer modulation
10 system and an enhancement layer modulation system, respectively, and performs symbol mapping of the enhancement layer over the position of a constellation based on the base layer modulation system.

FIG. 2 is a schematic diagram of an enhancement-layer transmission processing unit 300 according to the exemplary embodiment of the invention.
15 Referring to FIG. 2, the enhancement layer transmission processing unit 300 according to an exemplary embodiment of the invention includes an MPEG-4 system encoder 301, an MPEG-2 TS multiplexer 302, an external encoder 303, and a convolutional interleaver 304. Each component of FIG. 2 will now be described.

20 The MPEG-4 system encoder 301 performs objectification and synchronization of the enhancement layer video stream and enhancement layer audio stream, which are received from the MPEG-4 video encoder 100 and the MPEG-4 audio encoder 200, respectively, and outputs the synchronized

streams.

The MPEG-2 TS multiplexer 302 multiplexes the enhancement layer video stream and the enhancement layer audio stream, which are received from the MPEG-4 system encoder 301, into the enhancement layer transport stream,

5   and outputs the multiplexed enhancement layer transport stream.

The external encoder 303 receives an output stream of the MPEG-2 TS multiplexer 302 and encodes so as to have a robust error correction function. At this time, examples of channel encoding systems having the error correction function include a low density parity check (LDPC) code, a Reed Solomon (RS)

10   code, and a Bose-Chaudhuri-Hocquenghen (BCH) code system. In addition, the error correcting channel encoding can be performed by using a rate compatible punctured code (RCPC) that can provide variable channel coding rates, or a structure capable of changing the coding rate of transmission data.

The convolutional interleaver 304 receives a channel-encoded stream

15   from the external encoder 303 to remove time correlation between adjacent byte units within the data stream.

FIG. 3 is a schematic diagram of a hierarchical DMB transmitting unit 500 according to the exemplary embodiment of the invention.

Referring to FIG. 3, the hierarchical DMB transmitting unit 500 according

20   to the exemplary embodiment of the invention includes an energy dispersal scrambler 501, a turbo encoder 502, a time interleaver 503, a symbol mapper 504, a frequency interleaver 505, a differential modulator 506, a hierarchical symbol mapper 507, an inverse fast Fourier transform (IFFT) unit 508, a guard

interval inserter 509, and a convolutional encoder 510.   Each component of FIG. 3 will be described as follows.

The energy dispersal scrambler 501 receives a transport stream to disperse energy of the received transport stream.

5   The turbo encoder 502 performs turbo encoding of the output of the energy dispersal scrambler 501 on the enhancement layer based on an equal error protection (EEP) profile.

The time interleaver 503 receives the output of the turbo encoder 502 and performs time interleaving for each logic frame interval.   At this time, each

10   logic frame includes information of 24ms intervals at the time domain and has an interleaving depth of 384ms in total.

In addition, at the time interleaver 503, each of time interleaved sub-channel data is multiplexed in a main service multiplexer (MSM) and constituents a common interleaved frame (CIF).

15   The symbol mapper 504 is provided with a synchronous channel, a fast information channel (FIC), and a main service channel for effective data transmission so as to constituent a transmission frame of 24ms units.   For this configuration, the symbol mapper 504 performs quadrature phase shift keying (QPSK) symbol mapping.

20   The frequency interleaver 505 applies frequency interleaving so as to minimize the influence on frequency-selective fading.

The differential modulator 506 generates a phase reference signal and allows the generated phase reference signal to be located at a second symbol of

the transport frame. Based on this, the differential modulator 506 performs differential modulation with respect to an orthogonal frequency division multiplexing (OFDM) symbols that constituent the fast information channel (FIC) and the main service channel (MSC).

5   The hierarchical symbol mapper 507 receives the base layer signal and the enhancement layer signal passed through each differential modulator 506 and performs the symbol mapping of the enhancement layer according to the position of the constellation based on the modulation system of the base layer.

The inverse fast Fourier transform (IFFT) unit 508 transforms each

10   OFDM symbol that constitutes the transport frame into the time domain signal through the inverse fast Fourier transform (IFFT).

In order to eliminate inter-symbol interference (ISI), the guard interval inserter 509 inserts the data (i.e., guard interval) that corresponds to the latter 1/4 of the effective symbol interval in front of the effective symbol.

15   The convolutional encoder 510 performs convolutional encoding of the output of the energy dispersal scrambler 501 with respect to the base layer, with encoding rates that are different from each other, according to the unequal error protection (UEP) or equal error protection (EEP) profile.

In the hierarchical DMB transmitting unit 500 according to an exemplary

20   embodiment of the invention, the enhancement layer stream output signal that is output from the enhancement layer transmission processing unit 300 is input to the hierarchical symbol mapper 507 through the energy dispersal scrambler 501, the turbo encoder 502, the time interleaver 503, the symbol mapper 504, and the

frequency interleaver 505 in order to increase robustness to errors, rather than directly to the hierarchical symbol mapper 507.

The hierarchical DMB transmitting unit 500 according to the exemplary embodiment of the invention uses the turbo encoder 502 for the enhancement

5   layer, unlike the convolutional encoder 510 being used for the base layer.

If the stream modulated by the base layer is to be maintained with the same performance as the stream modulated only by the existing base layer, the performance of the stream modulated by the enhancement layer is relatively degraded.   That is, the entire transmission power of the stream modulated by

10   the base layer and the stream modulated by the enhancement layer cannot be increased infinitely but has a limited range.   However, since the stream modulated by the base layer should have transmission power that ensures a receiving coverage similar to that of the stream modulated only by the existing modulation method, the stream modulated by the enhancement layer has

15   relatively small transmission power, and this leads to a poor receiving performance at the terminal.

Further, the stream modulated by the enhancement layer described in the exemplary embodiment of the invention is mapped over stream modulated by the base layer.   Therefore, since the receiving performance of the base layer

20   stream has a close influence on the receiving performance of the enhancement layer stream, the information loss of the enhancement layer stream due to the receiving channel environment may become relatively large.

That is, the receiving environment of the stream regarding the

enhancement layer is poorer than the receiving environment of the base layer. Further, in order to increase a receiving efficiency, that is, in order to increase the receiving efficiency from the encoding step of the transmitting unit, more efficient encoding procedure is required.

5   Therefore, in the hierarchical DMB transmitting unit 500 according to the exemplary embodiment of the invention, a convolutional encoding system using the convolutional encoder 510 is used for the base layer, but the turbo encoder 502 that has better capability to receive the signal is used for the enhancement layer.

10   That is, instead of the convolutional encoding used in the base layer, the turbo encoder 502, which uses a double-binary turbo code based on puncturing, is used in the enhancement layer.

FIG. 4 is a schematic diagram of a hierarchical DMB transmitting unit 550 according to a second exemplary embodiment of the invention.

15   The hierarchical DMB transmitting unit 550 according to the second exemplary embodiment of the invention has the same function as the hierarchical DMB transmitting unit 500 according to the first exemplary embodiment of the invention, except that the positions of the hierarchical symbol mapper 507 are different.

20   Also, in the hierarchical DMB transmitting unit 550 according to the second exemplary embodiment of the invention, in order to increase the robustness to errors, the enhancement layer stream output signal that is output from the enhancement layer transmission processing unit 300 uses the energy

dispersal scrambler 501, the turbo encoder 502, the time interleaver 503, and the symbol mapper 504 as in the case of the base layer.

However, unlike the hierarchical DMB transmitting unit 500 according to the first exemplary embodiment of the invention, in the hierarchical DMB transmitting unit 550 according to the second exemplary embodiment of the invention, the base layer signal and the enhancement layer signal are input to the hierarchical symbol mapper 507 through the symbol mapper 504, respectively. Therefore, the hierarchical DMB transmitting unit 550 according to the second exemplary embodiment of the invention may omit the frequency interleaver 505 that is used only for the enhancement layer.

FIG. 5 is a schematic diagram of a turbo encoder 502 according to the exemplary embodiment of the invention.

The turbo encoder 502 according to the exemplary embodiment of the invention uses a double-binary circular recursive systematic code and includes a permutation unit 601, a constituent coding unit 602, a puncturing unit 603, and a codeword unit 604. Further, the coding rate of mother code of the turbo encoder 502 according to the exemplary embodiment of present invention is 1/4.

The output of the energy dispersal scrambler 501 that is input to the turbo encoder 502 according to the exemplary embodiment of the invention is represented by the vector $(a_i)_{i=0}^{I-1}$ of a logical frame I bit. N pairs of bits are input to the turbo encoder 502 as an input frame. That is, a double-binary vector $(x_i)_{i=0}^{N-1}$, $x_i = \{x_i^e, x_i^o\}$ of length N is the input frame of the turbo encoder 502. Length N of the input vector is determined by the data rate (bit rate), and

the allowed length is N= 384l, where l=1, 2, 3, 4.

In the case that the data rate is less than or equal to 128 kbits/s, i.e., l=3072, the binary vector $(a_i)_{i=0}^{I-1}$ of output logical frame I (=768l, l=1,2,3,4) bit of the energy dispersal scrambler 501 becomes an input-vector $(x_i)_{i=0}^{N-1}$ of the turbo encoder 502.   Here, N=I/2, $x_i = \{x_i^e, x_i^o\}$, $x_i^e = a_{2i}$, and $x_i^o = a_{2i+1}$.

Further, in the case that the data rate is larger than 128 kbits/s (i.e., I>3072 or I=3072K + 768l), K double binary vectors of which length N is 1536 are respectively encoded and the rest of double binary vectors of which length N is 384l are encoded.   Here, 0=K and l is an integer of 0<l<4.

That is, the vector is represented by a double binary vector as follows.

$$(a_i)_{i=0}^{I-1} = \{ (x_i^0)_{i=0}^{1535}, (x_i^2)_{i=0}^{1535}, ..., (x_i^{K-1})_{i=0}^{1535}, (x_i^K)_{i=0}^{384l-1} \}$$

Here, $x_i^K = \{x_i^{K,e}, x_i^{K,o}\}$, $x_i^{K,e} = a_{2(1536k+i)}$, and $x_i^{K,o} = a_{2(1536k+i)+1}$.

Hereafter, each component shown in FIG. 5 will be specifically described.

The permutation unit 601 replaces the permutation of the input vector. The permutation procedure of the permutation unit 601 includes an input-bit intra couple permutaion procedure (level 1) and an input-bit inter couple permutaion procedure (level 2).   Supposing that the variables needed in the permutaion procedure are P0, P1, P2, and P3, the variables for the original order of input bit pairs are i=0, 1, ..., N-1, and the variables for the replaced order are j=0, 1, ..., N-1, then the permutating procedure is as follows.

level 1

if jmod.2=0, $let\left(x_i^e, x_i^o\right) = \left(x_i^o, x_i^e\right)$ (invert the couple)

level 2

if jmod.4=0, then P=0

if jmod.4=1, then P=N/2+P1

if jmod.4=2, then P=P2

if jmod.4=3, then P=N/2+P3

$$i = \left(P_n \times j + P + 1\right) \bmod N$$

Table 1 indicates variables regarding permutation replacement according to the allowed input frame size.

(Table 1)

I	N	bytes	P_0	P_1	P_2	P_3
1	384	96	13	94	192	286
2	768	192	19	12	332	376
3	1152	288	23	404	388	16
4	1536	384	31	404	384	20

The constitution code unit 602 allows a triple-binary parity vector to be generated based on a circulation state. FIG. 6 is a view illustrating a configuration of the constitution code unit 602.

Referring to FIG. 6, in the constituent coding unit 602, the coding rate of the mother code is 1/4. A polynomial expression, which indicates a connection line of the constituent coding unit 602, can be represented as follows by using an octal or delay mark.

- Feedback branch: 15_{octal} or $1 + D + D^3$

- Parity bit P_1: 13octal or $1 + D^2 + D^3$

- Parity bit P_2: 11_{octal} or $1 + D^3$

- Parity bit P_3: 17_{octal} or $1 + D + D^2 + D^3$

5   An input x^e is connected to a tab "1" of a delay element, and an input

x^o is connected to tabs "1", "D", and "D^2" of the delay element.

C1 encoding is referred to as a process for generating a triple-binary

parity vector $(P_{1,i}^1, P_{2,i}^1, P_{3,i}^1)_{i=0}^{N-1}$ by inputting (switch position 1 in FIG. 5) vector

$(x_i)_{i=0}^{N-1}$, after initializing the circulation state of the constitution code unit 602   to

10   S_{C_1}.

Then, C2 encoding is referred to as a process for generating a

triple-binary parity vector $(P_{1,i}^2, P_{2,i}^2, P_{3,i}^2)_{i=0}^{N-1}$ by inputting (switch position 2 in

FIG. 5) vector $\Pi\{(x_i)_{i=0}^{N-1}\}$ that is permutated in the permutation unit 601, after

again initializing the circulation state of the constitution code unit 602 to S_{C_2}.

15   The circulation state will be described in more detail below.

In order to terminate a circular trellis of a turbo code, the constitution

code unit 602 initializes the circular trellis and then encodes it.   The circulation

state is determined by the size of a bit string to be input and the input bit string.

Accordingly, it calculates the circulation state value S_{C_1} for an input bit string of

20   the original sequence and the circulation state value S_{C_2} for the permutated

input bit string of the original sequence, respectively.

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The condition S ($0 \leq S \leq 7$) of the constitution code unit 602 can be represented by using each of memory values and can be represented as an expression $S = 4S_1 + 2S_2 + S_3$, and the circulation state value of the constitution code unit 602 is determined as follows.

First, the condition of the constitution code unit 602 is initialized to zero (0). In order to determine the circulation state S_{C_1}, pre-encoding for the vector input of original sequence is executed. Furthermore, in order to determine the circulation state S_{C_2}, pre-encoding for the permutated vector input is executed. In both cases, the final condition is S^o_{N-1}. At this time, additional information is not generated.

The circulation state S_{C_1} and S_{C_2} is obtained by using the following Table 2 according to the length N of the input vector and a final condition S^o_{N-1}. Table 2 is a corresponding map of the circulation state.

(Table 2)

S^o_{N-1} / N mod.7	0	1	2	3	4	5	6	7
1	$S_C=0$	$S_C=6$	$S_C=4$	$S_C=2$	$S_C=7$	$S_C=1$	$S_C=3$	$S_C=5$
2	$S_C=0$	$S_C=3$	$S_C=7$	$S_C=4$	$S_C=5$	$S_C=6$	$S_C=2$	$S_C=1$
3	$S_C=0$	$S_C=5$	$S_C=3$	$S_C=6$	$S_C=2$	$S_C=7$	$S_C=1$	$S_C=4$
4	$S_C=0$	$S_C=4$	$S_C=1$	$S_C=5$	$S_C=6$	$S_C=2$	$S_C=7$	$S_C=3$
5	$S_C=0$	$S_C=2$	$S_C=5$	$S_C=7$	$S_C=1$	$S_C=3$	$S_C=4$	$S_C=6$

6	$S_C = 0$	$S_C = 7$	$S_C = 6$	$S_C = 1$	$S_C = 3$	$S_C = 4$	$S_C = 5$	$S_C = 2$

The puncturing unit 603 performs a puncturing process with respect to the triple-binary parity vector, which is generated in the constituent coding unit 602, according to a data rate.

The input vector $(x_i)_{i=0}^{N-1}$ is not punctured in the puncturing unit 603. Each parity generated by the input vector $(x_i)_{i=0}^{N-1}$, that is, $(P_{1,i}^1)_{i=0}^{N-1}$, $(P_{2,i}^1)_{i=0}^{N-1}$, or $(P_{3,i}^1)_{i=0}^{N-1}$ is punctured in a different form according to a predetermined protection level and profile. Each parity generated by the permutated input vector $\Pi\{(x_i)_{i=0}^{N-1}\}$, that is, $(P_{1,i}^2)_{i=0}^{N-1}$, $(P_{2,i}^2)_{i=0}^{N-1}$, or $(P_{3,i}^2)_{i=0}^{N-1}$ is punctured in the same manner as $(P_{1,i}^1)_{i=0}^{N-1}$, $(P_{2,i}^1)_{i=0}^{N-1}$, or $(P_{3,i}^1)_{i=0}^{N-1}$.

The detailed puncturing process is as follows.

The puncturing unit 603 divides the parities $(P_{1,i})_{i=0}^{N-1}$, $(P_{2,i})_{i=0}^{N-1}$, and $(P_{3,i})_{i=0}^{N-1}$ into sub-blocks composed of 8 bits, and all of the divided sub-blocks are punctured by the same rule according to given puncturing indexes PI. A puncturing vector V_{PI} corresponding to each of the puncturing indexes PI is represented as follows.

$$V_{PI} = (V_{PI,0}, V_{PI,1}, \ldots, V_{PI,6}, V_{PI,7})$$

The (j+1)-th bit (j=0,1,...7) in each of the sub-blocks is punctured as follows according to an element $V_{PI,i}$ of the puncturing vector V_{PI}. When the element $V_{PI,i}$ is "0", the corresponding parity bit is punctured and is not

transported. Meanwhile, when the element $V_{PI,i}$ is "1", the corresponding parity bit is not punctured and is transported.

Table 3 indicates the puncturing vectors with respect to the parities P_1, P_2, and P_3.

(Table 3)

	$V_{PI}^{P_1} = (V_{PI,0}^{P_1}, \cdots V_{PI,7}^{P_1})$	$V_{PI}^{P_2} = (V_{PI,0}^{P_2}, \cdots V_{PI,7}^{P_2})$	$V_{PI}^{P_3} = (V_{PI,0}^{P_3}, \cdots V_{PI,7}^{P_3})$
PI= 1 R=8/9	1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
PI= 2 R=8/10	1 0 0 0 1 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
PI= 3 R=8/11	1 0 1 0 1 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
PI= 4 R=8/12	1 0 1 0 1 0 1 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
PI= 5 R=8/13	1 1 1 0 1 0 1 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
PI= 6 R=8/14	1 1 1 0 1 1 1 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
PI= 7 R=8/15	1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
PI= 8 R=8/16	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
PI= 9 R=8/17	1 1 1 1 1 1 1 1	1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
PI= 10 R=8/18	1 1 1 1 1 1 1 1	1 0 0 0 1 0 0 0	0 0 0 0 0 0 0 0
PI= 11 R=8/19	1 1 1 1 1 1 1 1	1 0 1 0 1 0 0 0	0 0 0 0 0 0 0 0
PI= 12 R=8/20	1 1 1 1 1 1 1 1	1 0 1 0 1 0 1 0	0 0 0 0 0 0 0 0
PI= 13 R=8/21	1 1 1 1 1 1 1 1	1 1 1 0 1 0 1 0	0 0 0 0 0 0 0 0
PI= 14 R=8/22	1 1 1 1 1 1 1 1	1 1 1 0 1 1 1 0	0 0 0 0 0 0 0 0
PI= 15 R=8/23	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0

PI= 16 R=8/24	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0
PI= 17 R=8/25	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 0 0 0 0 0 0 0
PI= 18 R=8/26	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 0 0 0 1 0 0 0
PI= 19 R=8/27	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 0 1 0 1 0 0 0
PI= 20 R=8/28	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 0 1 0 1 0 1 0
PI= 21 R=8/29	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 1 0 1 0 1 0
PI= 22 R=8/30	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 1 0 1 1 1 0
PI= 23 R=8/31	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 0
PI= 24 R=8/32	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1

In Table 3, puncturing indexes (PI=8, 12, 16, 24) are used in the equal error protection of the enhancement layer.

The codeword unit 604 generates a codeword by receiving the parity vectors, in which the puncturing process is performed.

Now, an encoding process applied to the fast information channel (FIC) for the enhancement layer, an encoding process applied to the main service channel (MSC) for the enhancement layer, and an extension process of FIG 0/1 that designates the protection level for the enhancement layer will be described.

By using a turbo encoder 502 according to the exemplary embodiment of the invention, the case where the mother coding rate is 1/4 will be described below.

First, the encoding process applied to the fast information channel (FIC) for the enhancement layer will be described.

Four 768-bit logic frames $(a_i)_{i=0}^{767}$ are transformed to the double-binary

vector $(x_i)_{i=0}^{1536}$ sequentially having the length N (N=1536) in the output of the

energy dispersal scrambler 501, and the triple-binary parity vector is generated

in the constitution code unit 602 of the turbo encoder 502.

5   Next, the parity vectors $(P_{1,i}^1)_{i=0}^{1535}$, $(P_{2,i}^1)_{i=0}^{1535}$, $(P_{1,i}^2)_{i=0}^{1535}$, and $(P_{2,i}^2)_{i=0}^{1535}$ are

not punctured in the puncturing unit 603 to be transported, and the parity vectors

$(P_{3,i}^1)_{i=0}^{1535}$ and $(P_{3,i}^2)_{i=0}^{1535}$ are punctured in the puncturing unit 603 and are not

transported.   That is, the parity vectors $(P_{3,i}^1)_{i=0}^{1535}$ and $(P_{3,i}^2)_{i=0}^{1535}$ are punctured

based on the puncturing index PI (PI=16) defined in Table 3.   At this time, the

10   coding rate of the codeword is 1/3 in the FIC.

The output stream of the codeword is represented by a binary vector

$(b_i)_{i=0}^{9215}$.   Here, the vector $(b_i)_{i=0}^{9215}$ is aligned in order of a 3072-bit encoder input

bit vector, a parity bit for an input bit vector, and a parity bit for a permutated

input bit vector.

15   That   is,   the   vector $(b_i)_{i=0}^{9215}$ is   represented   as   follow.

$$(b_i)_{i=0}^{9215} = \{(x_i^e, x_i^o)_{i=0}^{3071}, (P_{1,i}^1, P_{2,i}^1)_{i=0}^{3071}, (P_{1,i}^2, P_{2,i}^2)_{i=0}^{3071}\}$$

Next, the encoding process applied to the main service channel (MSC)

for the enhancement layer will be described.

Hereinafter, the protection profile and the protection level are defined,

20   and the puncturing process will be described by using these.   The protection

profile provides blocks of the mother codeword and puncturing indexes

corresponding to each of the blocks.

Unlike the encoding in the base layer, unequal error protection (UEP) is not applied for service components in the enhancement layer due to characteristic of a turbo code and an audio codec to be used. Only equal error protection (EEP) is performed in the enhancement layer.

The protection level 1 indicates the highest protection level in each of profile sets. The base layer supports the data rate having a multiple of 8k and 32k bits/sec, but the enhancement layer supports the data rate having only a multiple of 32k bits/sec.

Each logic frame corresponds to one or more data service components (packet mode) or single service component (stream mode) in the output of the energy dispersal scrambler 501. The service component is composed of the "I" bit vector $(a_i)_{i=0}^{I-1}$, where "I" is a function of the data rate.

Each binary vector $(a_i)_{i=0}^{I-1}$ is transformed into K+1 double-binary vectors $\left\{ (x_i^0)_{i=0}^{1535}, ...(x_i^{K-1})_{i=0}^{1535}, (x_i^K)_{i=0}^{384l-1} \right\}$ to be encoded, where $0 \leq = k$ and I is an integer of 0<l<4. Each parity P^1 and P^2 generated in this case is sequentially aligned to be divided into L blocks composed of 16 triple-binary vectors.

Each of L parity blocks is punctured based on the puncturing index PI defined in Table 3, and this relation is defined as an equal error protection (EEP) profile of the enhancement layer. The result of turbo encoding with respect to the given logic frame is represented by a binary vector $(b_i)_{i=0}^{M-1}$, where M is a

length.

When the data rate is a multiple of 32 kbit/s, four protection levels are defined. The four levels P (=1-C,2-C,3-C,4-C) correspond to the coding rates 1/4, 1/3, 2/5, and 1/2, respectively.

Table 4 indicates values of I, K, I, N, and L based on an allowed data rate.

(Table 4)

Data Rate (kbits/s)	I	K	I	N	L
32	768	0	1	384	24
. . .	. . .	. . .	. . .	. . .	. . .
32n	768n	|n/4|	$\dfrac{I-3072K}{768}$	1536 $(K \geq 1)$ and 384I	24n
. . .	. . .	. . .	. . .	. . .	. . .
1152	27648	9	0	1536	864

In Table 4, a maximum data rate is 1.152 Mbit/s. In this case, n is equal to 36, and the length of the codeword with respect to an information bit of 27648 bits and a coding rate of 1/2 is 55296.

Table 5 indicates the data rate and the protection level of the equal error

protection profile.

(Table 5)

(kbits/s)	P	L	PI
32n	4-c	24n	8
32n	3-c	24n	12
32n	2-c	24n	16
32n	1-c	24n	24

Finally, an extension method of FIG 0/1 for designating the protection level for enhancement layer will be described.

The protection level of each sub-channel that is transported to the main service channel (MSC) of a terrestrial DMB is designated within the sub-channel configuration field (FIG 0/1) that is transported through a fast information channel (FIC).

The exemplary embodiment of the invention is characterized in that the enhancement layer is modulated by using the turbo code so as to provide high quality service. In the conventional sub-channel configuration field (FIG 0/1), there is no information of protection level and coding rate when the turbo code is used.

In addition, an amount of data that is processed at one time, which is designated by the conventional sub-channel configuration field (FIG 0/1), is less compared to a case in which the data is processed by using the turbo code. Accordingly, information corresponding to the case in which the turbo code is

used should be added.

According to the exemplary embodiment of the invention, the protection level according to the turbo coding system and the information related thereto are included in the conventional sub-channel configuration field (FIG 0/1).

5   FIG. 7 illustrates a structure of a sub-channel configuration field (FIG 0/1) according to the invention. According to an exemplary embodiment of the present invention, the structure of the sub-channel configuration field (FIG 0/1) is extended as described below so as to designate the protection level of each sub-channel that is transported through the MSC of the enhancement layer of

10   the hierarchical DMB. A structure of a conventional sub-channel configuration field (FIG 0/1) is referred to in section 6.1 of the document ETSI EN 300 401.

Referring to FIG. 7, the sub-channel configuration field (FIG 0/1) is configured by a plurality of sub-channels 700. Each sub-channel 700 includes a sub-channel identifier (SubChId) field 701 of 6 bits and a start address field

15   702 of 10 bits, and a short/long form field 703 and a size and protection field 704 of 1 bit.

The short/long form field 703 represents whether the form used in the size and protection field is a short one or long one. When the short form is used in the size and protection field, a value of the short/long form field is "0".

20   On the other hand, when the long form is used in the size and protection field, a value of the short/long form field is "1".

A size and protection field 800 having the short form includes a table switch field 801 of 1 bit and a table index field 802 of 6 bits.

On the other hand, a size and protection field 900 having the long form includes an option field 901 of 3 bits, a protection level field 902 of 2 bits, and a sub-channel size field 903 of 10 bits.

The option field 901 is configured by 3 bits.   The option field 901 is used

5   for long-form coding.   Conventionally, only "000" and "001" have been used for the equal error protection (EEP).   However, according to the exemplary embodiment of the present invention, "010" is additionally used for the equal error protection of MSC of the enhancement layer.

That is, a new variable is added to the option field 901 of the size and

10   protection field 900 having the conventional long form so as to represent the turbo coding rate related to the protection level of the sub-channel at enhancement layer and the number of CUs that are necessary for transportation of sub-channel.

When the value of the option field 901 is "010", the protection level field

15   902 allocated by 2 bits designates values as follow.

00: protection level 1-C;

01: protection level 2-C;

10: protection level 3-C;

11: protection level 4-C.

20   The sub-channel size field 903 designates the number of CUs (range: 1 to 864) that each sub-channel within the MSC occupies according to the data rate.   The CU is the smallest unit (64 bits) that can be identified within the MSC.

In Table 6, the turbo coding rate of sub-channel at the enhancement

layer related to each protection level and the number of CUs that are necessary

for every data rate allowed by a multiple of 32 kbit/s are shown with respect to

four protection levels of the protection level field (02).

(Table 6)

Protection level	1-C	2-C	3-C	4-C
Turbo coding rate	1/4	1/3	2/5	1/2
Sub-channel size	48n	36n	30n	24n

5   Table 6 indicates a size of sub-channel in accordance with a different

data rate as a function of a data rate of 32n kbit/s (where n is an integer = 1).

The digital-multimedia-broadcasting receiving device according to an

exemplary embodiment of the invention will now be described.

10   FIG. 8 is a schematic diagram of a digital-multimedia-broadcasting

receiving device according to the exemplary embodiment of the invention, and

FIG. 9 is a detailed schematic diagram of a hierarchical DMB receiving unit of

FIG. 8.

Referring to FIG. 8, the digital-multimedia-broadcasting receiving

15   apparatus according to the exemplary embodiment of the invention includes a

hierarchical DMB receiving unit 10, a base layer receiving processor 20, an

enhancement layer receiving processor 30, an MPEG-4 video decoder 40, and

an MPEG-4 audio decoder 50. Each component shown in FIG. 8 will be

described.

20   As shown in FIG. 9, the hierarchical DMB receiving unit 10 includes an

RF tuner 11, an A/D converter 12, a fast Fourier transform (FFT) unit 13, a differential demodulator 14, a frequency de-interleaver 15, a symbol demapper 16, a time de-interleaver 17, a convolutional decoder 18, and an energy dispersal descrambler 19. Particularly, the frequency de-interleaver 15 of the

5   hierarchical DMB receiving unit 10 divides a base layer stream and an enhancement layer stream.

The hierarchical DMB receiving unit 10 receives the broadcasting signal, and outputs the base layer transport stream to the base layer receiving processor 20 and the enhancement layer transport stream to the enhancement

10   layer receiving processor 30 through a process corresponding to an inverse of the process of the hierarchical DMB transmitting unit.

The base layer receiving processor 20 performs the channel decoding of the base layer transport stream through the same process as in a conventional digital multimedia broadcasting receiver. The base layer receiving processor

15   20 performs the channel decoding of the base layer transport stream through processes in a convolutional decoder 21 and an RS decoder 22.

The enhancement layer receiving processor 30 performs the turbo decoding of the enhancement layer transport stream. The enhancement layer receiving processor 30 performs the turbo decoding of the enhancement layer

20   transport stream through processes in a layer symbol demapper 31, a time de-interleaver 32, a turbo decoder 33, and an energy diverse descrambler 34.

The transport streams of two layers, which are decoded in the base layer receiving processor 20 and in the enhancement layer receiving processor 30,

respectively, are divided into video, audio, and various kinds of additional information packets at TS de-multiplexers 23 and 35. Thereafter, the divided transport streams are extracted to be output through de-packetization and synchronization between the streams at MPEC-4 system decoders 24 and 36,

5   and a video stream and an audio stream of the two layers are extracted to be outputted.

The MPEG-4 video decoder 40 and the MPEG-4 audio decoder 50 perform a process of decoding the video and audio streams of the base layer and the enhancement layer, which are received from the MPEG-4 system

10   decoders 24 and 36, by using the correlation of the two layers, thereby providing high-quality video and audio to users.

When the digital-multimedia-broadcasting receiving apparatus according to the exemplary embodiment of the invention receives a broadcasting signal sent by a conventional system of digital multimedia broadcasting, only a base

15   layer stream is extracted and undergoes the same decoding process as in a conventional digital-multimedia-broadcasting receiving system. Thus, basic-quality video and audio are provided.

The base layer receiving processor 20 is the same component as a conventional digital multimedia broadcasting receiver. The base layer

20   receiving processor 20 includes the convolutional decoder 21, the RS decoder 22, the TS de-multiplexer 23, and the MPEG-4 system decoder 24, and performs an inverse process with respect to a process of encoding the base layer at the broadcasting transmitting device.

The enhancement layer receiving processor 30 includes the layer symbol de-mapper 31, the time de-interleaver 32, the turbo decoder 33, the energy diverse descrambler 34, the TS de-multiplexer 35, and the MPEG-4 system decoder 36, and performs an inverse process with respect to a process of encoding the enhancement layer in the broadcasting transmitting device. The exemplary embodiment of the present invention as described above is not necessarily implemented only through the method and apparatus. The exemplary embodiment of the present invention can be realized through a program or through a recording medium on which the program is recorded having a function corresponding to the construction of the exemplary embodiment of the present invention. This modification from the exemplary embodiment of the present invention can be easily realized to a person of ordinary skill in the art.

While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

【Industrial Applicability】

The present invention can provide a channel encoder for an enhancement layer in a digital-multimedia-broadcasting transmitting device, a digital broadcasting transmitting device, a digital broadcasting receiving device, and an extension structure of a sub-channel configuration field (FIG 0/1) for

designating a protection level of sub-channel at the enhancement layer.

【CLAIMS】

【Claim 1】

    A   channel   encoder   for   an   enhancement   layer   of   a
digital-multimedia-broadcasting transmitting device, which is included in a
5   hierarchical DMB transmitting unit that modulates a base layer transport stream
and an enhancement layer transport stream for multimedia data by a base layer
modulation system and an enhancement layer modulation system, respectively,
and performs symbol mapping of the enhancement layer over the position of a
constellation based on the base layer modulation system,

10   wherein the hierarchical DMB transmitting unit comprises:

        an   energy   dispersal   scrambler   that   disperses   energy   of   the
enhancement layer transport stream; and

        a turbo encoder that receives a double-binary input vector corresponding
to an output of the energy dispersal scrambler and encodes it by using a
15   double-binary circular recursive systematic code.

【Claim 2】

        The channel encoder of claim 1, wherein the turbo encoder comprises:

        a constituent coding unit that generates a parity vector based on a
20   coding rate of a mother code; and

        a codeword unit that generates a codeword by using a parity vector and
an input vector generated in the constituent coding unit.

【Claim 3】

The channel encoder of claim 2, wherein the constituent coding unit performs a first encoding process that generates a parity vector for the input vector after initializing a circulation state to a first condition, and performs a second encoding process that generates a parity vector for a permutated vector of the input vector after initializing the circulation state to a second condition.

【Claim 4】

The channel encoder of claim 3, wherein the circulation state is determined by a bit string and size of the input vector.

【Claim 5】

The channel encoder of claim 3, wherein the turbo encoder further comprises:

a permutation unit that replaces permutation of the input vector by an input bit-inter couple permutation procedure and an input bit-intra couple permutation procedure; and

a puncturing unit that performs puncturing of the parity vector generated in the constituent coding unit according to data rate.

【Claim 6】

The channel encoder of claim 5, wherein the puncturing unit divides the

parity vector into a plurality of sub-blocks, and the parity vector is punctured according to an element of a puncturing vector with respect to position in each of the sub-blocks.

5   【Claim 7】

The channel encoder of claim 6, wherein the length of the input vector is determined depending on the data rate, and an allowed length N is 384I, where I is 1, 2, 3, and 4.

10   【Claim 8】

The channel encoder of claim 7, wherein when the data rate is less than or equal to 128 kbits/s, and a binary vector $(a_i)_{i=0}^{I-1}$ corresponding to the output of the energy dispersal scrambler becomes an input vector $(x_i)_{i=0}^{N-1}$ of the turbo encoder, where N=I/2, $x_i = \{x_i^e, x_i^o\}$, $x_i^e = a_{2i}$, and $x_i^o = a_{2i+1}$.

15

【Claim 9】

The channel encoder of claim 7, wherein when the data rate is larger than 128 kbits/s, the turbo encoder encodes a plurality of input vectors having a length N (N=1536), respectively, and encodes the rest of double-binary vectors having other lengths that are lower that Ns.

20

【Claim 10】

The channel encoder of claim 2, wherein when the coding rate in the mother code of the turbo encoder is 1/4, the constituent coding unit generates a triple-binary parity vector, and a polynomial expression indicating a connection line of the constituent coding unit is represented as follows:

5   a feedback branch: $1+D+D^3$; a parity bit P_1: $1+D^2+D^3$; a parity bit P_2: $1+D^3$; and a parity bit P_3: $1+D+D^2+D^3$.

【Claim 11】

The channel encoder of claim 10, wherein:

10   the input vector is $(x_i)_{i=0}^{N-1}$, $x_i = \{x_i^e, x_i^o\}$ having a length N; and

the input x^e is connected to a tab "1" of a delay element, and the input x^o is connected to tabs "1", "D", and "D^2" of a delay element.

【Claim 12】

15   A digital-multimedia-broadcasting transmitting device, comprising:

a base layer transmission processing unit that receives a base layer stream, performs system encoding and multiplexing of the received base layer stream, and outputs a base layer transport stream;

an enhancement layer transmission processing unit that receives an

20   enhancement layer stream, performs system encoding and multiplexing of the received enhancement layer stream, and outputs an enhancement layer transport stream; and

36

a hierarchical digital-multimedia-broadcasting transmitting unit that modulates the base layer transport stream by a base layer modulation system, modulates the enhancement layer transport stream by a different system from the base layer modulation system, and performs symbol mapping of an
5   enhancement layer according to the position of a constellation based on the base layer modulation system.

【Claim 13】

The digital-multimedia-broadcasting transmitting device of claim 12,
10   wherein the base layer is modulated by a convolutional code system, and the enhancement layer is modulated by a turbo code system.

【Claim 14】

A digital-multimedia-broadcasting receiving device, comprising:
15   a hierarchical digital-multimedia-broadcasting receiver that receives a digital multimedia broadcasting signal and outputs it by dividing the received signal into a base layer transport stream and an enhancement layer transport stream;

a base layer receiving processor that performs channel decoding of the
20   base layer stream, de-multiplexes a transport stream, performs system decoding, and outputs a base layer audio and video stream; and

an enhancement layer receiving processor that performs turbo decoding of the enhancement layer stream, de-multiplexes a transport stream, performs

system decoding, and outputs an enhancement layer audio and video stream.

【Claim 15】

The digital-multimedia-broadcasting receiving device of claim 14,

5   wherein the enhancement layer receiving processor comprises:

a symbol de-mapper that performs symbol de-mapping of the

enhancement layer stream;

a turbo decoder that performs turbo decoding of the symbol de-mapped

enhancement layer stream;

10   a de-multiplexer that performs de-multiplexing by dividing the turbo

decoded enhancement layer stream into video and audio packets; and

a system decoder that performs de-packeting of the de-multiplexing

audio and video packet, performs synchronization between streams, and

outputs an enhancement layer audio and video stream.

15

【Claim 16】

An extension structure of sub-channel configuration field (FIG 0/1) in a

digital-multimedia-broadcasting transmitting device that modulates a base layer

transport stream and an enhancement layer transport stream by a base layer

20   modulation system and an enhancement layer modulation system, respectively,

and performs symbol mapping of the enhancement layer according to the

position of a constellation based on the base layer modulation system, the

extension structure comprising:

an option field that has a predetermined value for equal error protection

of the enhancement layer; and

a protection level field that includes protection level information when the

value of an option field is the predetermined value.

5

【Claim 17】

The extension structure of claim 16, wherein the predetermined value is

a value when the enhancement layer is modulated by using a turbo code.

10   【Claim 18】

The extension structure of claim 17, wherein,

when the option field is the predetermined value,

the protection level field has four protection levels, and

a turbo coding rate related to each protection level is 1/4, 1/3, 2/5, and

15   1/2.

【Claim 19】

The extension structure of claim 18, further comprising

a sub-channel size field that designates the number of capacity units

20   (CU), which are the smallest unit that can be identified within a main service

channel (MSC), according to a data rate, the capacity units being occupied by

each sub-channel within the main service channel,

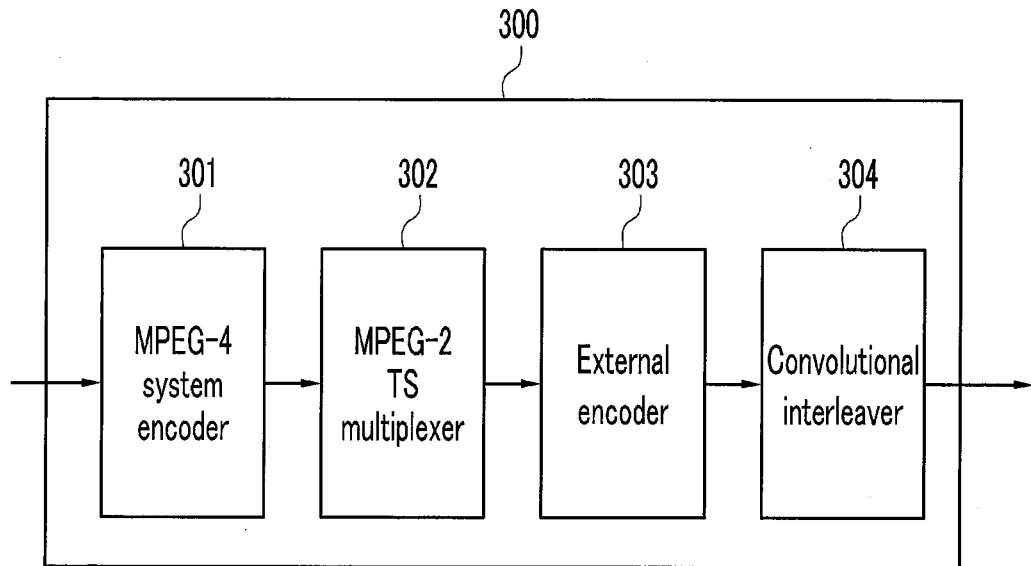wherein the turbo coding rate of the enhancement layer related to the

protection level and the size of sub-channel is as follows:

Protection level	1-C	2-C	3-C	4-C
Turbo coding rate	1/4	1/3	2/5	1/2
Sub-channel size	48n	36n	30n	24n

【FIG. 1】

【FIG. 2】
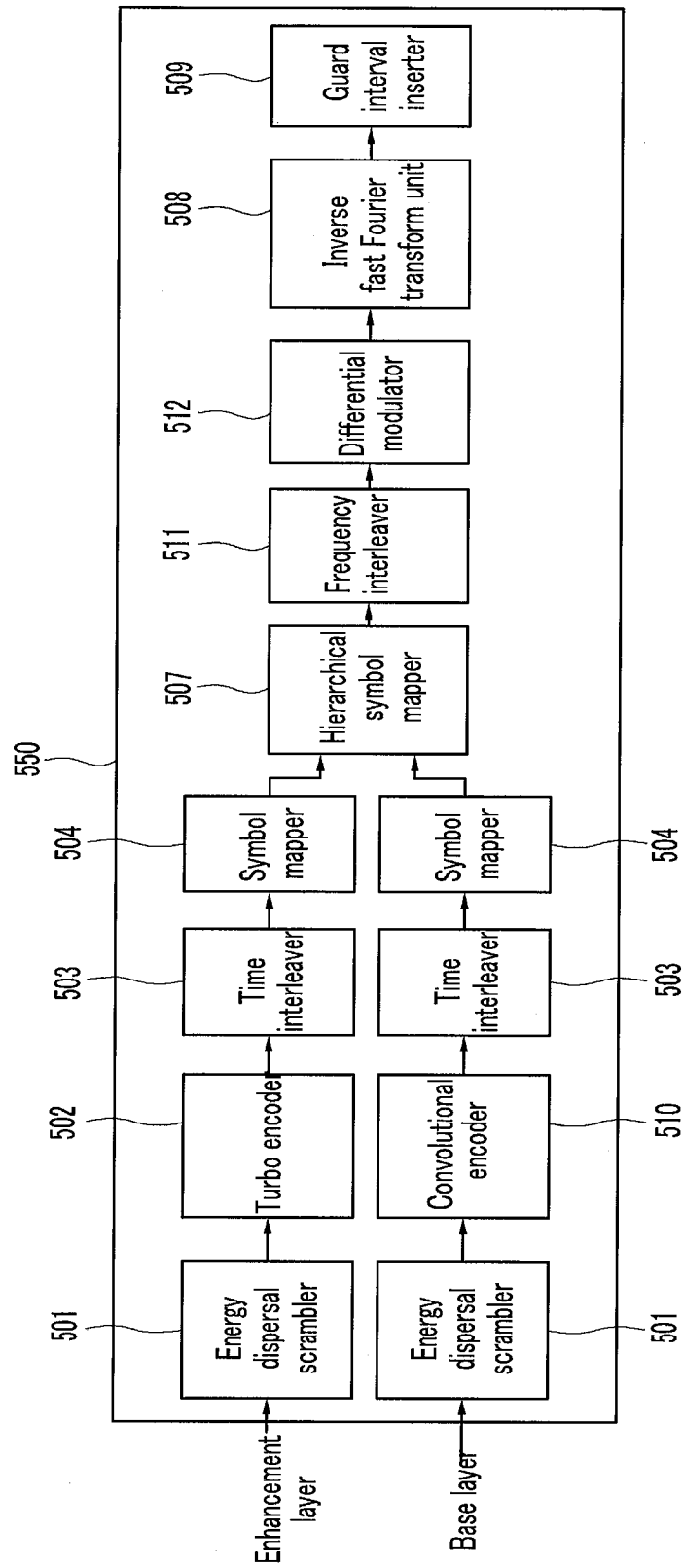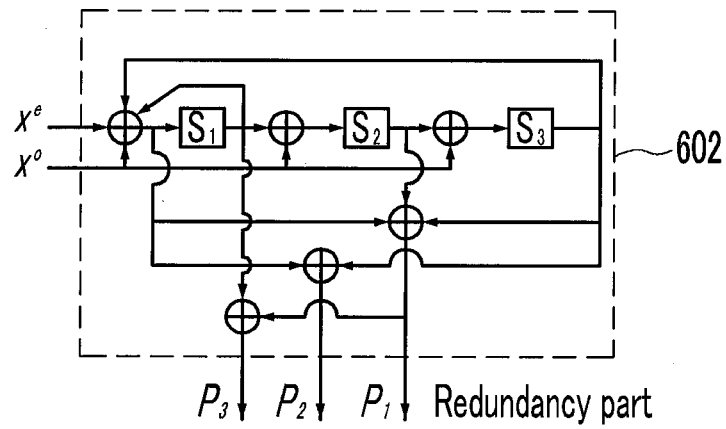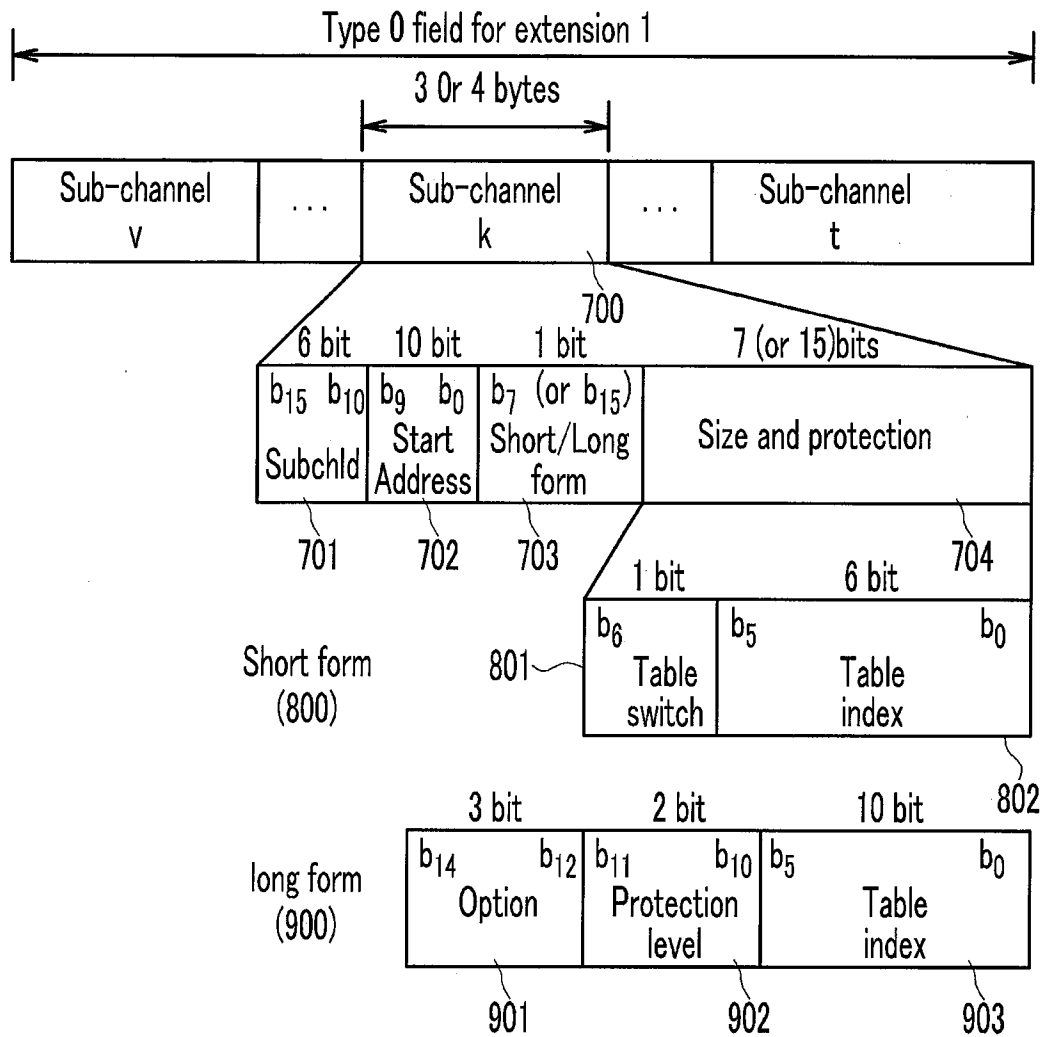
300

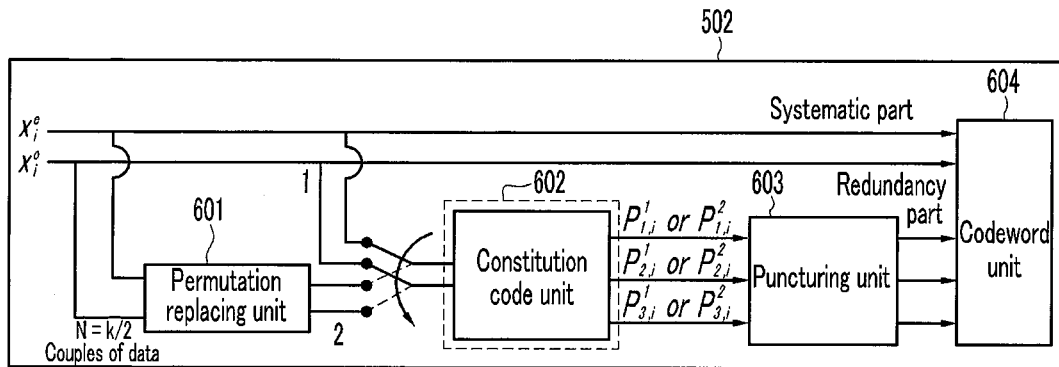| 301	302	303	304
MPEG-4 system encoder	MPEG-2 TS multiplexer	External encoder	Convolutional interleaver

【FIG. 3】

【FIG. 4】

【FIG. 5】

【FIG. 6】

【FIG. 7】

【FIG. 8】
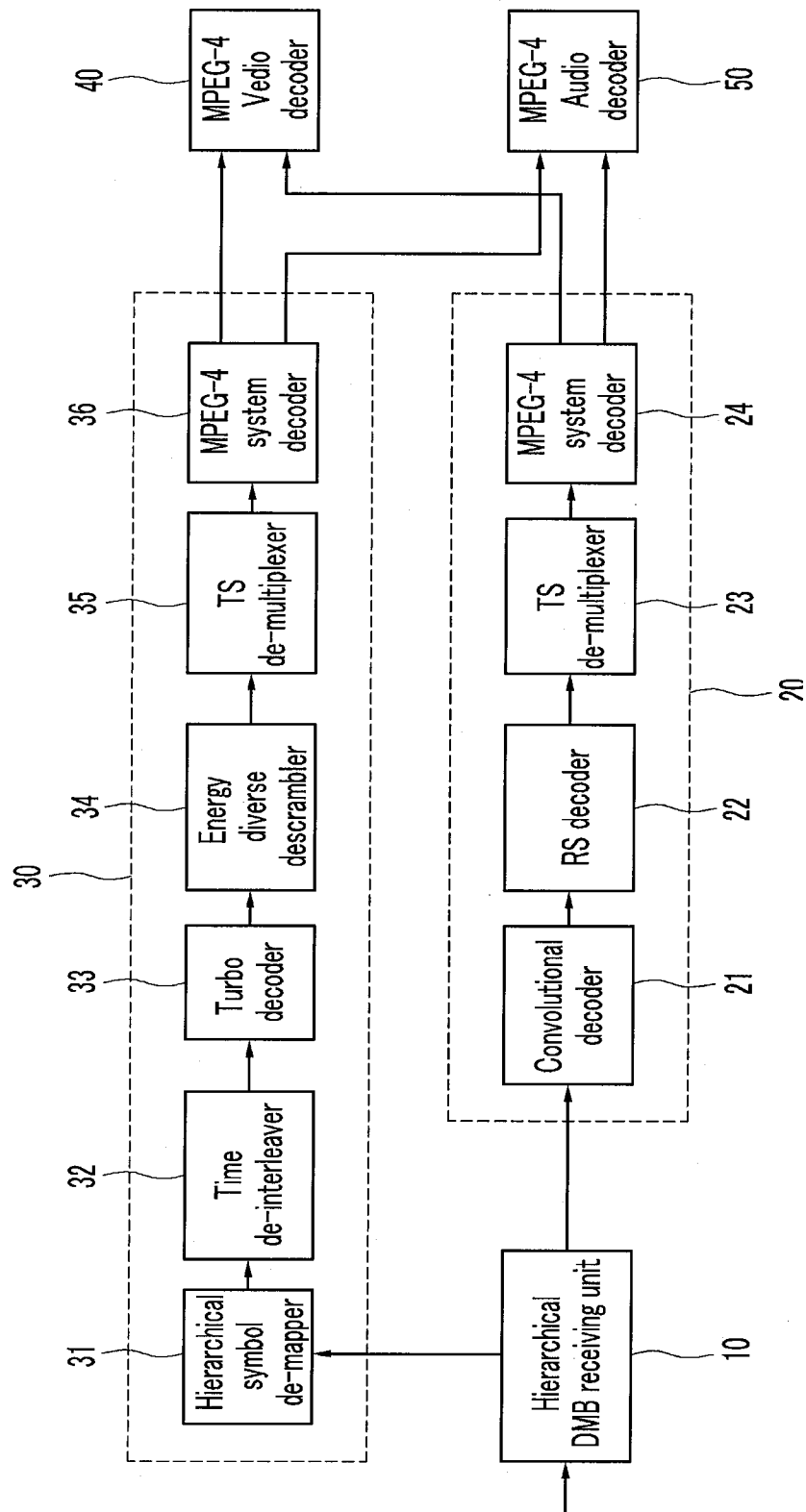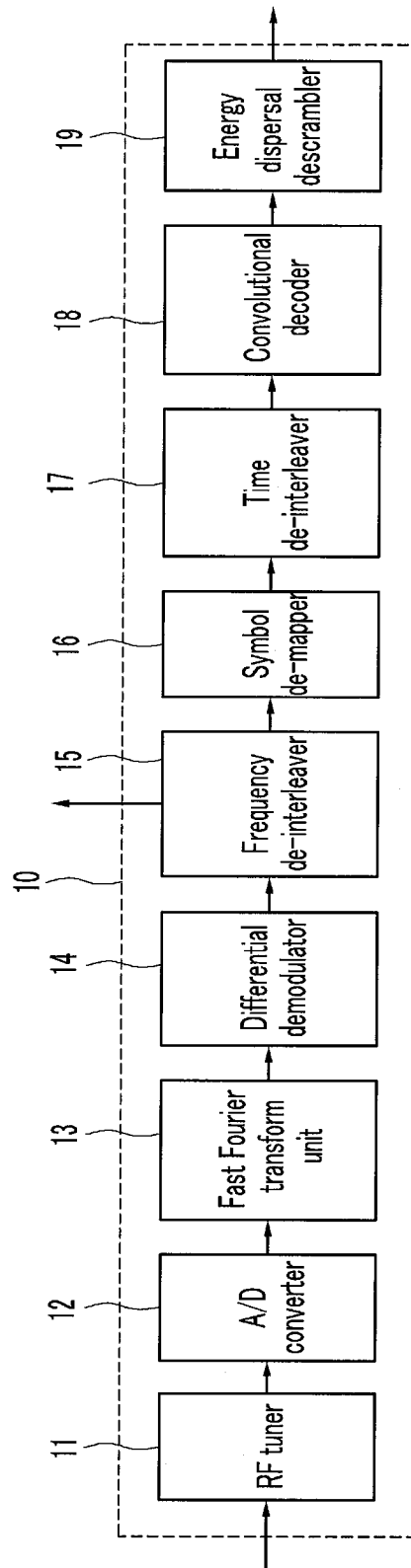
【FIG. 9】

A.	CLASSIFICATION OF SUBJECT MATTER

H04N 7/24(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B.	FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 8 H04N H01L H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models since 1975
Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS, SEARCH TERMS: Channel, Encoding, Base layer, DMB and similar terms

C.	DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20060262227 A1 (YOUNG-HO JEONG) 23 NOVEMBER 2006 See abstract; Paragraph[0012] - Paragraph[0017]; Paragraph[0030] - Paragraph[0046]; Figures 2-4.	1-19
A	US 20060171283 A1 (VIJAYAN et al.) 03 AUGUST 2006 See abstract; Paragraph[0008] - Paragraph[0017]; Paragraph[0089] - Paragraph[0114]; Figures 7-9.	1-19
A	WO 2006076451 A2 (QUALCOMM INCORPORATED) 20 JULY 2006 See abstract; Paragraph[0008] - Paragraph[0015]; Paragraph[0052] - Paragraph[0092]; Paragraph[0104] - Paragraph[0112]; Figures 3-5, 8,9.	1-19

☐ Further documents are listed in the continuation of Box C.	☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority
"A" document defining the general state of the art which is not considered to be of particular relevance	date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination
"O" document referring to an oral disclosure, use, exhibition or other means	being obvious to a person skilled in the art
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Date of the actual completion of the international search	Date of mailing of the international search report
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