

CLAIMS

1. A method for channel encoding using a Low-Density Parity-Check (LDPC) code, the method comprising:

- determining a number of parity bits for puncturing;
- determining a number of parity bit sets based on the number of parity bits for puncturing, each of the parity bit sets being formed by parity bits at a predetermined interval; and
- puncturing parity bits based on the number of parity bit sets and a predetermined order of parity bit sets to be punctured.

2. The method of claim 1, wherein the predetermined order of parity bit sets is determined as 6, 4, 18, 9, 13, 8, 15, 20, 5, 17, 2, 24, 10, 22, 12, 3, 16, 23, 1, 14, 0, 21, 19, 7, 11, when a codeword length is 16200.

3. The method of claim 1, wherein the predetermined order of parity bit sets is determined as 27, 13, 29, 32, 5, 0, 11, 21, 33, 20, 25, 28, 18, 35, 8, 3, 9, 31, 22, 24, 7, 14, 17, 4, 2, 26, 16, 34, 19, 10, 12, 23, 1, 6, 30, 15, when a codeword length is 16200.

4. The method of claim 1, further comprising:
additionally puncturing parity bits, when the number of the parity bits for puncturing is not a multiple of the length of the one parity bit sets.

5. The method of claim 1, further comprising:
transmitting remaining bits, except for the punctured bits.

6. The method of claim 1, wherein the number of parity bit sets is being determined by below equation

$$A = \left\lceil \frac{N_p}{M_1} \right\rceil,$$

where A denotes the number of parity bit sets for puncturing, N_p denotes the number of parity bits for puncturing, M_I denotes the length of one parity bit sets.

7. The method of claim 6, wherein the parity bit sets are formed by below equation

$$P_j = \{p_k \mid j \equiv k \bmod q, 0 \leq k < N_I - K_I\},$$

where P_j denotes the j^{th} parity bit set, N_I denotes a length of an LDPC codeword, K_I denotes a length of an information word, M_I denotes the length of one parity bit sets, q is a value satisfying $q = (N_I - K_I) / M_I$, where K_I / M_I is an integer, and $0 \leq j < q$.

8. The method of claim 7, wherein:

all of parity bits corresponding to A parity bit sets $P_{\pi(0)}, P_{\pi(1)}, \dots, P_{\pi(A-1)}$ are punctured;
and

additionally $(N_p - 360 A)$ parity bits among the parity bits corresponding to $P_{\pi(A)}$ are punctured.

9. An apparatus for channel encoding using a Low-Density Parity-Check (LDPC) code, the apparatus comprising:

a puncturing pattern applier for determining a number of parity bits for puncturing, determining a number of parity bit sets based on the number of parity bits for puncturing, each of the parity bit sets being formed by parity bits at a predetermined interval, and puncturing parity bits based on the number of parity bit sets and a predetermined order of parity bit sets to be punctured.

10. The apparatus of claim 9, wherein the predetermined order of parity bit sets is determined as 6, 4, 18, 9, 13, 8, 15, 20, 5, 17, 2, 24, 10, 22, 12, 3, 16, 23, 1, 14, 0, 21, 19, 7, 11, when a codeword length is 16200.

11. The apparatus of claim 9, wherein the predetermined order of parity bit sets is

determined as 27, 13, 29, 32, 5, 0, 11, 21, 33, 20, 25, 28, 18, 35, 8, 3, 9, 31, 22, 24, 7, 14, 17, 4, 2, 26, 16, 34, 19, 10, 12, 23, 1, 6, 30, 15, when a codeword length is 16200.

12. The apparatus of claim 9, wherein the puncturing pattern applier additionally punctures parity bits, when the number of the parity bits for puncturing is not a multiple of the length of the one parity bit sets.

13. The apparatus of claim 9, further comprising:
a transmitter for transmitting remaining bits, except for the punctured bits.

14. The apparatus of claim 9, wherein the number of parity bit sets is being determined by below equation

$$A = \left\lceil \frac{N_p}{M_1} \right\rceil,$$

where A denotes the number of parity bit sets for puncturing, N_p denotes the number of parity bits for puncturing, M_1 denotes the length of one parity bit sets.

15. The apparatus of claim 14, wherein the parity bit sets are formed by below equation

$$P_j = \{p_k \mid j \equiv k \bmod q, 0 \leq k < N_1 - K_1\},$$

where P_j denotes the j^{th} parity bit set, N_1 denotes a length of an LDPC codeword, K_1 denotes a length of an information word, M_1 denotes the length of one parity bit sets, q is a value satisfying $q = (N_1 - K_1) / M_1$, where K_1/M_1 is an integer, and $0 \leq j < q$.

16. The apparatus of claim 15, wherein:

all of parity bits corresponding to A parity bit sets $P_{\pi(0)}, P_{\pi(1)}, \dots, P_{\pi(A-1)}$ are punctured;
and
additionally $(N_p - 360 A)$ parity bits among the parity bits corresponding to $P_{\pi(A)}$ are

punctured.

17. A method for channel decoding using a Low-Density Parity-Check (LDPC) code, the method comprising:

demodulating a signal transmitted from a transmitter;

determining position information of the punctured parity bits by estimating information about a predetermined order of parity bit sets to be punctured and the number of parity bit sets ; and

decoding data using the position information of the punctured parity bits,

wherein determining position of punctured parity bits comprises,

determining a number of parity bits to be punctured; and

determining a number of parity bit sets to be punctured based on the determined number of parity bits to be punctured; and

acquiring a predetermined order of parity bit sets.

18. The method of claim 17, wherein the predetermined order of parity bit sets is 6, 4, 18, 9, 13, 8, 15, 20, 5, 17, 2, 24, 10, 22, 12, 3, 16, 23, 1, 14, 0, 21, 19, 7, 11, when a codeword length is 16200.

19. The method of claim 17, wherein the predetermined order of parity bit sets is 27, 13, 29, 32, 5, 0, 11, 21, 33, 20, 25, 28, 18, 35, 8, 3, 9, 31, 22, 24, 7, 14, 17, 4, 2, 26, 16, 34, 19, 10, 12, 23, 1, 6, 30, 15, when a codeword length is 16200.

20. The method of claim 17, further comprising:

determining that puncturing parity bits additionally is punctured, when the number of the parity bits for puncturing is not a multiple of the length of the one parity bit sets.

21. The method of claim 17, further comprising:

receiving remaining bits, except for the punctured bits.

22. The method of claim 17, wherein the number of parity bit sets is being determined by below equation

$$A = \left\lceil \frac{N_p}{M_1} \right\rceil,$$

where A denotes the number of parity bit sets to be punctured, N_p denotes the number of parity bits to be punctured, M_1 denotes the length of one parity bit sets,

23. The method of claim 22, wherein the parity bit sets are formed by below equation

$$P_j = \{p_k \mid j \equiv k \bmod q, 0 \leq k < N_1 - K_1\},$$

where P_j denotes the j^{th} parity bit set, N_1 denotes a length of a LDPC codeword, K_1 denotes a length of an information word, M_1 denotes the length of one parity bit sets, q is a value satisfying $q = (N_1 - K_1) / M_1$, where K_1/M_1 is an integer, and $0 \leq j < q$.

24. The method of claim 23, wherein:

determining that all of parity bits corresponding to A parity bit sets $P_{\pi(0)}, P_{\pi(1)}, \dots, P_{\pi(A-1)}$ are punctured; and

determining that additionally $(N_p - 360 \cdot A)$ parity bits among the parity bits corresponding to $P_{\pi(A)}$ are punctured.

25. An apparatus for channel decoding using a Low-Density Parity-Check (LDPC) code, the apparatus comprising:

a demodulator for demodulating a signal transmitted from a transmitter;

a puncturing pattern decision unit for determining position information of the punctured parity bits by estimating information about a predetermined order of parity bit sets to be punctured and the number of parity bit sets ; and

a decoder for decoding data using the position information of the punctured parity bits, wherein determining position of punctured parity bits comprises,

determining a number of parity bits to be punctured; and
determining a number of parity bit sets to be punctured based on the determined number of parity bits to be punctured; and
acquiring a predetermined order of parity bit sets.

26. The apparatus of claim 25, wherein the predetermined order of parity bit sets is 6, 4, 18, 9, 13, 8, 15, 20, 5, 17, 2, 24, 10, 22, 12, 3, 16, 23, 1, 14, 0, 21, 19, 7, 11, when a codeword length is 16200.

27. The apparatus of claim 25, wherein the predetermined order of parity bit sets is 27, 13, 29, 32, 5, 0, 11, 21, 33, 20, 25, 28, 18, 35, 8, 3, 9, 31, 22, 24, 7, 14, 17, 4, 2, 26, 16, 34, 19, 10, 12, 23, 1, 6, 30, 15, when a codeword length is 16200.

28. The apparatus of claim 25, wherein the puncturing pattern decision unit determines that puncturing parity bits additionally is punctured, when the number of the parity bits for puncturing is not a multiple of the length of the one parity bit sets.

29. The apparatus of claim 25, further comprising:
a receiver for receiving remaining bits, except for the punctured bits.

30. The apparatus of claim 25, wherein the number of parity bit sets is being determined by below equation

$$A = \left\lceil \frac{N_p}{M_1} \right\rceil,$$

where A denotes the number of parity bit sets to be punctured, N_p denotes the number of parity bits to be punctured, M_1 denotes the length of one parity bit sets.

31. The apparatus of claim 30, wherein the parity bit sets are formed by below equation

$$P_j = \{p_k \mid j \equiv k \bmod q, 0 \leq k < N_1 - K_1\},$$

where P_j denotes the j^{th} parity bit set, N_1 denotes a length of a LDPC codeword, K_1 denotes a length of an information word, M_1 denotes the length of one parity bit sets, q is a value satisfying $q = (N_1 - K_1) / M_1$, where K_1/M_1 is an integer, and $0 \leq j < q$.

32. The apparatus of claim 31, wherein the puncturing pattern decision unit determines that all of parity bits corresponding to A parity bit sets $P_{\pi(0)}, P_{\pi(1)}, \dots, P_{\pi(A-1)}$ are punctured, and determines that additionally $(N_p - 360 A)$ parity bits among the parity bits corresponding to $P_{\pi(A)}$ are punctured.

WHAT IS CLAIMED IS:

1. A method for channel encoding using a Low-Density Parity-Check (LDPC) code, the method comprising:

determining a number of parity bits for puncturing;

determining a number of parity bit sets based on the number of parity bits for puncturing, each of the parity bit sets being formed by parity bits at a predetermined interval; and

puncturing parity bits based on the number of parity bit sets and a predetermined order of parity bit sets to be punctured,

wherein the predetermined order of parity bit sets is determined as 6, 4, 18, 9, 13, 8, 15, 20, 5, 17, 2, 24, 10, 22, 12, 3, 16, 23, 1, 14, 0, 21, 19, 7, 11, when a codeword length is 16200.

2. The method of claim 1, further comprising:

additionally puncturing parity bits, when the number of the parity bits for puncturing is not a multiple of the length of the one parity bit sets.

3. The method of claim 1, further comprising:

transmitting remaining bits, except for the punctured bits.

4. The method of claim 1, wherein the number of parity bit sets is being determined by below equation

$$A = \left\lceil \frac{N_p}{M_1} \right\rceil,$$

where A denotes the number of parity bit sets for puncturing, N_p denotes the number of parity bits for puncturing, M_1 denotes the length of one parity bit sets.

5. The method of claim 4, wherein the parity bit sets are formed by below equation

$$P_j = \{p_k \mid j \equiv k \bmod q, 0 \leq k < N_I - K_I\},$$

where P_j denotes the j^{th} parity bit set, N_I denotes a length of an LDPC codeword, K_I denotes a length of an information word, M_1 denotes the length of

one parity bit sets, q is a value satisfying $q = (N_I - K_I) / M_I$, where K_I/M_I is an integer, and $0 \leq j < q$.

6. The method of claim 5, wherein:

all of parity bits corresponding to A parity bit sets $P_{\pi(0)}, P_{\pi(1)}, \dots, P_{\pi(A-1)}$ are punctured; and

additionally $(N_p - 360 A)$ parity bits among the parity bits corresponding to $P_{\pi(A)}$ are punctured.

7. A method for channel encoding using a Low-Density Parity-Check (LDPC) code, the method comprising:

determining a number of parity bits for puncturing;

determining a number of parity bit sets based on the number of parity bits for puncturing, each of the parity bit sets being formed by parity bits at a predetermined interval; and

puncturing parity bits based on the number of parity bit sets and a predetermined order of parity bit sets to be punctured,

wherein the predetermined order of parity bit sets is determined as 27, 13, 29, 32, 5, 0, 11, 21, 33, 20, 25, 28, 18, 35, 8, 3, 9, 31, 22, 24, 7, 14, 17, 4, 2, 26, 16, 34, 19, 10, 12, 23, 1, 6, 30, 15, when a codeword length is 16200.

8. The method of claim 7, further comprising:

additionally puncturing parity bits, when the number of the parity bits for puncturing is not a multiple of the length of the one parity bit sets.

9. The method of claim 7, further comprising:

transmitting remaining bits, except for the punctured bits.

10. The method of claim 7, wherein the number of parity bit sets is being determined by below equation

$$A = \left\lceil \frac{N_p}{M_1} \right\rceil,$$

where A denotes the number of parity bit sets for puncturing, N_p denotes the number of parity bits for puncturing, M_1 denotes the length of one parity bit sets.

11. The method of claim 10, wherein the parity bit sets are formed by below equation

$$P_j = \{p_k \mid j \equiv k \bmod q, 0 \leq k < N_I - K_I\},$$

where P_j denotes the j^{th} parity bit set, N_I denotes a length of an LDPC codeword, K_I denotes a length of an information word, M_I denotes the length of one parity bit sets, q is a value satisfying $q = (N_I - K_I) / M_I$, where K_I/M_I is an integer, and $0 \leq j < q$.

12. The method of claim 11, wherein:

all of parity bits corresponding to A parity bit sets $P_{\pi(0)}, P_{\pi(1)}, \dots, P_{\pi(A-1)}$ are punctured; and

additionally $(N_p - 360 \cdot A)$ parity bits among the parity bits corresponding to $P_{\pi(A)}$ are punctured.

13. An apparatus for channel encoding using a Low-Density Parity-Check (LDPC) code, the apparatus comprising:

a puncturing pattern applier for determining a number of parity bits for puncturing, determining a number of parity bit sets based on the number of parity bits for puncturing, each of the parity bit sets being formed by parity bits at a predetermined interval, and puncturing parity bits based on the number of parity bit sets and a predetermined order of parity bit sets to be punctured,

wherein the predetermined order of parity bit sets is determined as 6, 4, 18, 9, 13, 8, 15, 20, 5, 17, 2, 24, 10, 22, 12, 3, 16, 23, 1, 14, 0, 21, 19, 7, 11, when a codeword length is 16200.

14. The apparatus of claim 13, wherein the puncturing pattern applier additionally punctures parity bits, when the number of the parity bits for puncturing is not a multiple of the length of the one parity bit sets.

15. The apparatus of claim 13, further comprising:

a transmitter for transmitting remaining bits, except for the punctured bits.

16. The apparatus of claim 13, wherein the number of parity bit sets is being determined by below equation

$$A = \left\lceil \frac{N_p}{M_1} \right\rceil,$$

where A denotes the number of parity bit sets for puncturing, N_p denotes the number of parity bits for puncturing, M_1 denotes the length of one parity bit sets.

17. The apparatus of claim 16, wherein the parity bit sets are formed by below equation

$$P_j = \{p_k \mid j \equiv k \bmod q, 0 \leq k < N_I - K_I\},$$

where P_j denotes the j^{th} parity bit set, N_I denotes a length of an LDPC codeword, K_I denotes a length of an information word, M_1 denotes the length of one parity bit sets, q is a value satisfying $q = (N_I - K_I) / M_1$, where K_I/M_1 is an integer, and $0 \leq j < q$.

18. The apparatus of claim 17, wherein:

all of parity bits corresponding to A parity bit sets $P_{\pi(0)}, P_{\pi(1)}, \dots, P_{\pi(A-1)}$ are punctured; and

additionally $(N_p - 360 \cdot A)$ parity bits among the parity bits corresponding to $P_{\pi(A)}$ are punctured.

19. An apparatus for channel encoding using a Low-Density Parity-Check (LDPC) code, the apparatus comprising:

a puncturing pattern applier for determining a number of parity bits for puncturing, determining a number of parity bit sets based on the number of parity bits for puncturing, each of the parity bit sets being formed by parity bits at a predetermined interval, and puncturing parity bits based on the number of parity bit sets and a predetermined order of parity bit sets to be punctured,

wherein the predetermined order of parity bit sets is determined as 27, 13, 29, 32, 5, 0, 11, 21, 33, 20, 25, 28, 18, 35, 8, 3, 9, 31, 22, 24, 7, 14, 17, 4, 2, 26, 16, 34, 19, 10, 12, 23, 1, 6, 30, 15, when a codeword length is 16200.

20. The apparatus of claim 19, wherein the puncturing pattern applier additionally punctures parity bits, when the number of the parity bits for puncturing is not a multiple of the length of the one parity bit sets.

21. The apparatus of claim 19, further comprising:
a transmitter for transmitting remaining bits, except for the punctured bits.

22. The apparatus of claim 19, wherein the number of parity bit sets is being determined by below equation

$$A = \left\lceil \frac{N_p}{M_1} \right\rceil,$$

where A denotes the number of parity bit sets for puncturing, N_p denotes the number of parity bits for puncturing, M_1 denotes the length of one parity bit sets.

23. The apparatus of claim 22, wherein the parity bit sets are formed by below equation

$$P_j = \{p_k \mid j \equiv k \bmod q, 0 \leq k < N_I - K_I\},$$

where P_j denotes the j^{th} parity bit set, N_I denotes a length of an LDPC codeword, K_I denotes a length of an information word, M_1 denotes the length of one parity bit sets, q is a value satisfying $q = (N_I - K_I) / M_1$, where K_I/M_1 is an integer, and $0 \leq j < q$.

24. The apparatus of claim 23, wherein:

all of parity bits corresponding to A parity bit sets $P_{\pi(0)}, P_{\pi(1)}, \dots, P_{\pi(A-1)}$ are punctured; and

additionally $(N_p - 360 A)$ parity bits among the parity bits corresponding to $P_{\pi(A)}$ are punctured.