

CLAIMS

1. A data sending method, applied to an orthogonal frequency division multiplexing (OFDM) system based on single-carrier frequency-division multiple access (SC-FDMA), comprising:

5 acquiring a first data stream, wherein the first data stream comprises a plurality of coded data symbols;

performing an N-dimensional orthogonal transformation on the first data stream to obtain an orthogonally transformed first data stream, wherein $N \geq 2$;

10 performing a modulation processing on the orthogonally transformed first data stream to obtain a first radio frequency signal, wherein the first radio frequency signal doesn't comprise a reference signal or a pilot signal; and

sending the first radio frequency signal, wherein the first radio frequency signal is used to enable a receiving end of the first radio frequency signal to obtain channel information by using the first radio frequency signal which doesn't comprise the reference signal or the pilot signal.

15 2. The method of claim 1, wherein performing the N-dimensional orthogonal transformation on the first data stream to obtain the orthogonally transformed first data stream comprises:

mapping each bit of data symbol in the first data stream into at least two bits of data symbols to obtain a sequence expanded first data stream, and performing the N-dimensional orthogonal transformation on the sequence expanded first data stream to obtain an expanded and orthogonally transformed first data stream; or,

20 performing the N-dimensional orthogonal transformation on the first data stream to obtain the orthogonally transformed first data stream, and mapping each bit of data symbol in the orthogonally transformed first data stream into at least two bits of data symbols to obtain an expanded and orthogonally transformed first data stream.

25 3. The method of claim 2, wherein mapping the each bit of data symbol in the first data stream into the at least two bits of data symbols to obtain the sequence expanded first data stream comprises:

mapping the each bit of data symbol in the first data stream into the at least two bits of data symbols by using an expansion sequence in a preset expansion sequence group to obtain the sequence expanded first data stream;

30 wherein mapping the each bit of data symbol in the orthogonally transformed first data stream

into the at least two bits of data symbols to obtain the expanded and orthogonally transformed first data stream comprises:

5 mapping the each bit of data symbol in the orthogonally transformed first data stream into the at least two bits of data symbols by using an expansion sequence in the preset expansion sequence group to obtain the expanded and orthogonally transformed first data stream;

wherein the preset expansion sequence group comprises at least two expansion sequences.

4. The method of any one of claims 1 to 3, wherein the N-dimensional orthogonal transformation comprises one of: an N-dimensional discrete cosine transformation, an N-dimensional discrete Hartley transformation, or an N-dimensional Welch Hadamard transformation.

10 5. The method of any one of claims 1 to 3, wherein performing the modulation processing on the orthogonally transformed first data stream to obtain the first radio frequency signal comprises:

sequentially performing a subcarrier mapping, an M-dimensional inverse discrete Fourier transformation, and a cyclic prefix addition on the orthogonally transformed first data stream to obtain a second data stream, wherein $M \geq 2$; and

15 performing a digital-to-analog conversion and an up-conversion on the second data stream to obtain the first radio frequency signal.

6. The method of claim 5, wherein before performing the N-dimensional orthogonal transformation on the first data stream to obtain the orthogonally transformed first data stream, the method further comprises:

20 converting a serial first data stream into a parallel first data stream.

7. The method of claim 6, wherein performing the N-dimensional orthogonal transformation on the first data stream to obtain the orthogonally transformed first data stream comprises:

performing the N-dimensional orthogonal transformation on the parallel first data stream to obtain a parallel and orthogonally transformed first data stream;

25 wherein sequentially performing the subcarrier mapping, the M-dimensional inverse discrete Fourier transformation, and the cyclic prefix addition on the orthogonally transformed first data stream to obtain the second data stream comprises:

sequentially performing the subcarrier mapping and the M-dimensional inverse discrete Fourier transformation on the parallel and orthogonally transformed first data stream to obtain a

parallel third data stream;

converting the parallel third data stream into a serial third data stream; and

performing the cyclic prefix addition on the serial third data stream to obtain the second data stream.

5 8. A data receiving method, applied to an orthogonal frequency division multiplexing (OFDM), system based on single-carrier frequency-division multiple access (SC-FDMA), comprising:

receiving a first radio frequency signal, wherein the first radio frequency signal comprises a plurality of data symbols subjected to an N-dimensional orthogonal transformation, and $N \geq 2$, wherein the first radio frequency signal doesn't comprise a reference signal or a pilot signal;

10 obtaining channel information by using the first radio frequency signal which doesn't comprise the reference signal or the pilot signal;

performing a demodulation on the first radio frequency signal to obtain a demodulated first data stream;

15 performing an N-dimensional inverse orthogonal transformation on the demodulated first data stream to obtain an inverse orthogonally transformed first data stream; and

detecting the inverse orthogonally transformed first data stream to obtain a first data stream.

9. The method of claim 8, wherein performing the N-dimensional inverse orthogonal transformation on the demodulated first data stream to obtain the inverse orthogonally transformed first data stream comprises:

20 performing an inverse mapping on each at least two bits of data symbols in the demodulated first data stream into one bit of data symbol to obtain a sequence de-expanded first data stream, and performing the N-dimensional inverse orthogonal transformation on the sequence de-expanded first data stream to obtain a de-expanded and inverse orthogonally transformed first data stream; or,

25 performing the N-dimensional inverse orthogonal transformation on the demodulated first data stream to obtain the inverse orthogonally transformed first data stream, and performing an inverse mapping on each at least two bits of data symbols in the inverse orthogonally transformed first data stream into one bit of data symbol to obtain a de-expanded and inverse orthogonally transformed first data stream.

10. The method of claim 9, wherein performing the inverse mapping on the each at least two bits of data symbols in the demodulated first data stream into the one bit of data symbol to obtain the sequence de-expanded first data stream comprises:

5 performing an inverse mapping on each at least two bits of data symbols in the demodulated first data stream into one bit of data symbol in sequence by using each extension sequence in a preset extension sequence group until the sequence de-expanded first data stream is obtained, and determining an expansion sequence used in the first radio frequency signal according to the sequence de-expanded first data stream;

10 wherein performing the inverse mapping on the each at least two bits of data symbols in the inverse orthogonally transformed first data stream into the one bit of data symbol to obtain the de-expanded and inverse orthogonally transformed first data stream comprises:

15 performing an inverse mapping on each at least two bits of data symbols in the inverse orthogonally transformed first data stream into one bit of data symbol in sequence by using each extension sequence in the preset extension sequence group until the de-expanded and inverse orthogonally transformed first data stream is obtained, and determining an expansion sequence used in the first radio frequency signal according to the de-expanded and inverse orthogonally transformed first data stream;

wherein the preset expansion sequence group comprises at least two expansion sequences.

20 11. The method of any one of claims 8 to 10, wherein the N-dimensional orthogonal transformation comprises one of: an N-dimensional discrete cosine transformation, an N-dimensional discrete Hartley transformation, or an N-dimensional Welch Hadamard transformation.

12. The method of claim 8 to 10, wherein performing the modulation processing on the first radio frequency signal to obtain the demodulated first data stream comprises:

25 performing a down-conversion and an analog-to-digital conversion on the first radio frequency signal to obtain the demodulated first data stream;

wherein performing the N-dimensional inverse orthogonal transformation on the demodulated first data stream to obtain the inverse orthogonally transformed first data stream comprises:

30 sequentially performing a cyclic prefix removal, an M-dimensional discrete Fourier transformation, a subcarrier de-mapping, and an equalization processing on the demodulated first data stream to obtain a fourth data stream, where $M \geq 2$; and

performing the N-dimensional inverse orthogonal transformation on the fourth data stream to obtain the inverse orthogonally transformed first data stream.

5 13. The method of claim 12, wherein sequentially performing the cyclic prefix removal, the M-dimensional discrete Fourier transformation, the subcarrier de-mapping, and the equalization processing on the demodulated first data stream to obtain the fourth data stream comprises:

performing a cyclic prefix removal on the demodulated first data stream to obtain a serial fifth data stream; and

10 converting the serial fifth data stream into a parallel fifth data stream, and sequentially performing the M-dimensional discrete Fourier transformation, the subcarrier de-mapping, and the equalization processing on the parallel fifth data stream to obtain a parallel fourth data stream.

14. The method of claim 13, wherein performing the N-dimensional inverse orthogonal transformation on the fourth data stream to obtain the inverse orthogonally transformed first data stream comprises:

15 performing the N-dimensional inverse orthogonal transformation on the parallel fourth data stream to obtain a parallel and inverse orthogonally transformed first data stream; and

converting the parallel and inverse orthogonally transformed first data stream into a serial and inverse orthogonally transformed first data stream.

15. A data sending apparatus, applied to an orthogonal frequency division multiplexing (OFDM), system based on single-carrier frequency-division multiple access (SC-FDMA), comprising:

20 a data acquisition module, which is configured to acquire a first data stream, wherein the first data stream comprises a plurality of encoded data symbols;

an orthogonal transformation module, which is configured to perform an N-dimensional orthogonal transformation on the first data stream to obtain an orthogonally transformed first data stream, wherein $N \geq 2$;

25 a signal modulation module, which is configured to perform a modulation processing on the orthogonally transformed first data stream to obtain a first radio frequency signal, wherein the first radio frequency signal doesn't comprise a reference signal or a pilot signal; and

30 a signal sending module, which is configured to send the first radio frequency signal, wherein the first radio frequency signal is used to enable a receiving end of the first radio frequency signal to obtain channel information by using the first radio frequency signal which doesn't comprise

the reference signal or the pilot signal.

16. The apparatus of claim 15, wherein the orthogonal transformation module is configured to: map each bit of data symbol in the first data stream into at least two bits of data symbols to obtain a sequence expanded first data stream, and perform the N-dimensional orthogonal transformation on the sequence expanded first data stream to obtain an expanded and orthogonally transformed first data stream; or, perform the N-dimensional orthogonal transformation on the first data stream to obtain the orthogonally transformed first data stream, and map each bit of data symbol in the orthogonally transformed first data stream into at least two bits of data symbols to obtain an expanded and orthogonally transformed first data stream.

17. A data receiving apparatus, applied to an orthogonal frequency division multiplexing (OFDM) system based on single-carrier frequency-division multiple access (SC-FDMA), comprising:

a signal receiving module, which is configured to receive a first radio frequency signal, wherein the first radio frequency signal comprises a plurality of data symbols subjected to an N-dimensional orthogonal transformation, and $N \geq 2$, wherein the first radio frequency signal doesn't comprise a reference signal or a pilot signal;

a signal demodulation module, which is configured to obtain channel information by using the first radio frequency signal which doesn't comprise the reference signal or the pilot signal and perform a demodulation on the first radio frequency signal to obtain a demodulated first data stream;

an orthogonal inverse transformation module, which is configured to perform an N-dimensional inverse orthogonal transformation on the demodulated first data stream to obtain an inverse orthogonally transformed first data stream; and

a data acquisition module, which is configured to detect the inverse orthogonally transformed first data stream to obtain a first data stream.

18. A data transmission system, comprising: a data sending terminal and a data receiving terminal; wherein,

the data sending terminal comprises the data sending apparatus of any one of claims 15 to 16; and

the data receiving terminal comprises the data receiving apparatus of claim 17.

19. A storage medium, storing a computer program, wherein the computer program, when executed by a processor, implements the data sending method of any one of claims 1 to 7.

20. A storage medium, storing a computer program, wherein the computer program, when executed by a processor, implements the data receiving method of any one of claims 8 to 14.