CLAIMS

1. A transmission method comprising:

an encoding step of generating an encoded block using a predetermined error correction block encoding method;

a generation step of generating a first transmission signal z1 and a second transmission signal z2 by performing, for each of a plurality of slots, a precoding process on a first modulated signal s1 and a second modulated signal s2 that have been generated from the encoded block; and

a transmission step of transmitting the first transmission signal z1 and the second transmission signal z2 from a first antenna and a second antenna, respectively, in the same frequency at the same time, wherein

the generation step

further selects one matrix from among N matrices F[i], where i is an integer no less than 0 and no more than N − 1, and N is an integer 3 or greater, by hopping between the matrices over each of the plurality of slots, the N matrices F[i] each defining the precoding process, and

generates the transmission signal z1 and the transmission signal z2 by performing, for each of the plurality of slots, a precoding process corresponding to the selected matrix F[i] on the first modulated signal s1 and the second modulated signal s2,

the first transmission signal z1 and the second transmission signal z2 satisfy $(z1, z2)^T = F[i](s1, s2)^T$,

$(z1, z2)^T$ being a transposed vector of (z1, z2), and

$(s1, s2)^T$ being a transposed vector of (s1, s2)

the N matrices F[i] satisfy

$$F[i] = \frac{1}{\sqrt{\alpha^2+1}} \begin{pmatrix} e^{j\theta_{11}(i)} & \alpha \times e^{j(\theta_{11}(i)+\lambda)} \\ \alpha \times e^{j\theta_{21}(i)} & e^{j(\theta_{21}(i)+\lambda+\pi)} \end{pmatrix}$$

where λ represents an arbitrary angle, and α represents a positive real number excluding 1,

$\theta_{11}(i)$ and $\theta_{21}(i)$ satisfy

$e^{j(\theta_{11}(x)-\theta_{21}(x))} \neq e^{j(\theta_{11}(y)-\theta_{21}(y))}$ for $\forall x, \forall y\ (x \neq y; x, y = 0,1,2,\cdots, N-2, N-1)$, and

the generation step performs the generation corresponding to the encoded block by selecting each of the N matrices F[i] the same number of times.

2. The transmission method of claim 1, wherein

$\theta_{11}(i)$ and $\theta_{21}(i)$ of the N matrices F[i] further satisfy either

$$\frac{e^{j(\theta_{11}(x+1)-\theta_{21}(x+1))}}{e^{j(\theta_{11}(x)-\theta_{21}(x))}} = e^{j\left(\frac{2\pi}{N}\right)} \quad \text{for } \forall x\ (x = 0,1,2,\cdots, N-2)$$

or

$$\frac{e^{j(\theta_{11}(x+1)-\theta_{21}(x+1))}}{e^{j(\theta_{11}(x)-\theta_{21}(x))}} = e^{j\left(-\frac{2\pi}{N}\right)} \quad \text{for } \forall x\ (x = 0,1,2,\cdots, N-2).$$

3. A transmission apparatus comprising:

an encoding unit configured to generate an encoded block using a predetermined error correction block encoding method;

a generation unit configured to generate a first transmission signal z1 and a second transmission signal z2 by performing, for each of a plurality of slots, a precoding process on a first modulated signal s1 and a second modulated signal s2 that have been generated from the encoded block; and

a transmission unit configured to transmit the first transmission signal z1 and the second transmission signal z2 from a first antenna and a second antenna, respectively, in the same frequency at the same time, wherein

the generation unit

is further configured to select one matrix from among N matrices F[i], where i is an integer no less than 0 and no more than N − 1, and N is an integer 3 or greater, by hopping between the matrices over each of the plurality of slots, the N matrices F[i] each defining the precoding process, and

generates the transmission signal z1 and the transmission signal z2 by

performing, for each of the plurality of slots, a precoding process corresponding to the selected matrix F[i] on the first modulated signal s1 and the second modulated signal s2,

the first transmission signal z1 and the second transmission signal z2 satisfy $(z1, z2)^T = F[i](s1, s2)^T$,

$(z1, z2)^T$ being a transposed vector of (z1, z2), and

$(s1, s2)^T$ being a transposed vector of (s1, s2)

the N matrices F[i] satisfy

$$F[i]=\frac{1}{\sqrt{\alpha^2+1}}\begin{pmatrix} e^{j\theta_{11}(i)} & \alpha\times e^{j(\theta_{11}(i)+\lambda)} \\ \alpha\times e^{j\theta_{21}(i)} & e^{j(\theta_{21}(i)+\lambda+\pi)} \end{pmatrix}$$

where λ represents an arbitrary angle, and α represents a positive real number excluding 1,

$\theta_{11}(i)$ and $\theta_{21}(i)$ satisfy

$e^{j(\theta_{11}(x)-\theta_{21}(x))} \neq e^{j(\theta_{11}(y)-\theta_{21}(y))}$ for $\forall x, \forall y\ (x \neq y; x, y = 0,1,2,\cdots, N-2, N-1)$, and

the generation unit performs the generation corresponding to the encoded block by selecting each of the N matrices F[i] the same number of times.

4. The transmission apparatus of claim 3, wherein

$\theta_{11}(i)$ and $\theta_{21}(i)$ of the N matrices F[i] further satisfy either

$$\frac{e^{j(\theta_{11}(x+1)-\theta_{21}(x+1))}}{e^{j(\theta_{11}(x)-\theta_{21}(x))}} = e^{j\left(\frac{2\pi}{N}\right)} \quad \text{for } \forall x\ (x = 0,1,2,\cdots, N-2)$$

or

$$\frac{e^{j(\theta_{11}(x+1)-\theta_{21}(x+1))}}{e^{j(\theta_{11}(x)-\theta_{21}(x))}} = e^{j\left(-\frac{2\pi}{N}\right)} \quad \text{for } \forall x\ (x = 0,1,2,\cdots, N-2).$$

5. A reception method comprising:

an acquisition step of acquiring a reception signal obtained by receiving a first

transmission signal z1 and a second transmission signal z2 transmitted from a first antenna and a second antenna, respectively, in the same frequency at the same time, the first transmission signal z1 and the second transmission signal z2 having been generated as a result of a predetermined generation process performed on a first modulated signal s1 and a second modulated signal s2, the first modulated signal s1 and the second modulated signal s2 having been generated from an encoded block generated with use of a predetermined error correction block encoding method; and

a demodulation step of performing a demodulation process on the acquired reception signal, the demodulation process corresponding to the predetermined generation process, wherein

the predetermined generation process includes:

selecting one matrix from among N matrices F[i], where i is an integer no less than 0 and no more than N − 1, and N is an integer 3 or greater, by hopping between the matrices over each of the plurality of slots, the N matrices F[i] defining a precoding process that is performed on a plurality of modulated signals, and

generating the transmission signal z1 and the transmission signal z2 by performing, for each of the plurality of slots, a precoding process corresponding to the selected matrix F[i] on the first modulated signal s1 and the second modulated signal s2,

the first transmission signal z1 and the second transmission signal z2 satisfy $(z1, z2)^T = F[i](s1, s2)^T$,

$(z1, z2)^T$ being a transposed vector of (z1, z2), and

$(s1, s2)^T$ being a transposed vector of (s1, s2)

the N matrices F[i] satisfy

$$F[i] = \frac{1}{\sqrt{\alpha^2+1}} \begin{pmatrix} e^{j\theta_{11}(i)} & \alpha \times e^{j(\theta_{11}(i)+\lambda)} \\ \alpha \times e^{j\theta_{21}(i)} & e^{j(\theta_{21}(i)+\lambda+\pi)} \end{pmatrix}$$

where λ represents an arbitrary angle, and α represents a positive real number excluding 1,

$\theta_{11}(i)$ and $\theta_{21}(i)$ satisfy

$e^{j(\theta_{11}(x)-\theta_{21}(x))} \neq e^{j(\theta_{11}(y)-\theta_{21}(y))}$ for $\forall x, \forall y\ (x \neq y; x, y = 0,1,2,\cdots,N-2,N-1)$, and

in the predetermined generation process corresponding to the encoded block, each of the N matrices F[i] is selected the same number of times.

6. The reception method of claim 5, wherein

$\theta_{11}(i)$ and $\theta_{21}(i)$ of the N matrices F[i] further satisfy either

$$\frac{e^{j(\theta_{11}(x+1)-\theta_{21}(x+1))}}{e^{j(\theta_{11}(x)-\theta_{21}(x))}} = e^{j\left(\frac{2\pi}{N}\right)} \quad \text{for } \forall x\,(x = 0,1,2,\cdots,N-2)$$

or

$$\frac{e^{j(\theta_{11}(x+1)-\theta_{21}(x+1))}}{e^{j(\theta_{11}(x)-\theta_{21}(x))}} = e^{j\left(-\frac{2\pi}{N}\right)} \quad \text{for } \forall x\,(x = 0,1,2,\cdots,N-2)$$

7. A reception apparatus comprising:

an acquisition unit configured to acquire a reception signal obtained by receiving a first transmission signal z1 and a second transmission signal z2 transmitted from a first antenna and a second antenna, respectively, in the same frequency at the same time, the first transmission signal z1 and the second transmission signal z2 having been generated as a result of a predetermined generation process performed on a first modulated signal s1 and a second modulated signal s2, the first modulated signal s1 and the second modulated signal s2 having been generated from an encoded block generated with use of a predetermined error correction block encoding method; and

a demodulation unit configured to perform a demodulation process on the acquired reception signal, the demodulation process corresponding to the predetermined generation process, wherein

the predetermined generation process includes:

selecting one matrix from among N matrices F[i], where i is an integer no less than 0 and no more than N − 1, and N is an integer 3 or greater, by hopping between the matrices over each of the plurality of slots, the N matrices F[i] defining a

precoding process that is performed on a plurality of modulated signals, and

generating the transmission signal z1 and the transmission signal z2 by performing, for each of the plurality of slots, a precoding process corresponding to the selected matrix F[i] on the first modulated signal s1 and the second modulated signal s2,

the first transmission signal z1 and the second transmission signal z2 satisfy $(z1, z2)^T = F[i](s1, s2)^T$,

$(z1, z2)^T$ being a transposed vector of (z1, z2), and

$(s1, s2)^T$ being a transposed vector of (s1, s2)

the N matrices F[i] satisfy

$$F[i]=\frac{1}{\sqrt{\alpha^2+1}}\begin{pmatrix} e^{j\theta_{11}(i)} & \alpha\times e^{j(\theta_{11}(i)+\lambda)} \\ \alpha\times e^{j\theta_{21}(i)} & e^{j(\theta_{21}(i)+\lambda+\pi)} \end{pmatrix}$$

where λ represents an arbitrary angle, and α represents a positive real number excluding 1,

$\theta_{11}(i)$ and $\theta_{21}(i)$ satisfy

$e^{j(\theta_{11}(x)-\theta_{21}(x))} \neq e^{j(\theta_{11}(y)-\theta_{21}(y))}$ for $\forall x, \forall y\ (x \neq y; x, y = 0,1,2,\cdots, N-2, N-1)$, and

in the predetermined generation process corresponding to the encoded block, each of the N matrices F[i] is selected the same number of times.

8. The reception apparatus of claim 7, wherein

$\theta_{11}(i)$ and $\theta_{21}(i)$ of the N matrices F[i] further satisfy either

$$\frac{e^{j(\theta_{11}(x+1)-\theta_{21}(x+1))}}{e^{j(\theta_{11}(x)-\theta_{21}(x))}} = e^{j\left(\frac{2\pi}{N}\right)} \quad \text{for } \forall x\ (x = 0,1,2,\cdots, N-2)$$

or

$$\frac{e^{j(\theta_{11}(x+1)-\theta_{21}(x+1))}}{e^{j(\theta_{11}(x)-\theta_{21}(x))}} = e^{j\left(-\frac{2\pi}{N}\right)} \quad \text{for } \forall x\ (x = 0,1,2,\cdots, N-2).$$

CLAIMS

1. A precoding method for generating, from a plurality of baseband signals, a plurality of precoded signals to be transmitted over the same frequency bandwidth at the same time, comprising the steps of:

selecting a matrix F[i] from among N matrices while switching between the N matrices, the N matrices defining precoding performed on the plurality of baseband signals, i being an integer from 0 to N – 1, and N being an integer at least two; and

generating a first precoded signal z1 and a second precoded signal z2 by precoding, in accordance with the selected matrix F[i], a first baseband signal s1 generated from a first plurality of bits and a second baseband signal s2 generated from a second plurality of bits, a first encoded block and a second encoded block being generated respectively as the first plurality of bits and the second plurality of bits using a predetermined error correction block encoding method, the first baseband signal s1 and the second baseband signal s2 being generated respectively from the first encoded block and the second encoded block to have M symbols each, the first precoded signal z1 and the second precoded signal z2 being generated to have M slots each by precoding a combination of the first baseband signal s1 and the second baseband signal s2, M being an integer at least two,

the first precoded signal z1 and the second precoded signal z2 satisfying the equation $(z1, z2)^T = F[i](s1, s2)^T$.

2. A precoding apparatus for generating, from a plurality of baseband signals, a plurality of precoded signals to be transmitted over the same frequency bandwidth at the same time, comprising:

a weighting information generation unit configured to select a matrix F[i] from among N matrices while switching between the N matrices, the N matrices

defining precoding performed on the plurality of baseband signals, i being an integer from 0 to N – 1, and N being an integer at least two;

a weighting unit configured to generate a first precoded signal z1 and a second precoded signal z2 by precoding, in accordance with the selected matrix F[i], a first baseband signal s1 generated from a first plurality of bits and a second baseband signal s2 generated from a second plurality of bits;

an error correction coding unit configured to generate a first encoded block as the first plurality of bits and a second encoded block as the second plurality of bits using a predetermined error correction block encoding method; and

a mapper configured to generate a baseband signal with M symbols from the first encoded block and a baseband signal with M symbols from the second encoded block, M being an integer at least two,

the first precoded signal z1 and the second precoded signal z2 satisfying the equation $(z1, z2)^T = F[i](s1, s2)^T$, and

the weighting unit generating precoded signals with M slots by precoding a combination of the baseband signal generated from the first encoded block and the baseband signal generated from the second encoded block.