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Date: April 8, 2025

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The document is designated as:

- **Chen-WO2015131494A2.pdf**

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(12) International application published in accordance with the Patent Cooperation Treaty

(19) International Bureau of the World Intellectual Property Organization

(43) International publication date
September 11, 2015 (11.09.2015)

WIPO | PCT

(10) International publication No.:
WO 2015/131494 A2

(51) International patent classification No.: ***H04B 7/06*** (2006.01)

(21) International application No.: PCT/CN2014/084568

(22) International application date: August 15, 2014 (15.08.2014)

(25) Application language: Chinese

(26) Publication language: Chinese

(30) Priority: CN
201410077620.5 March 4, 2014 (04.03.2014)

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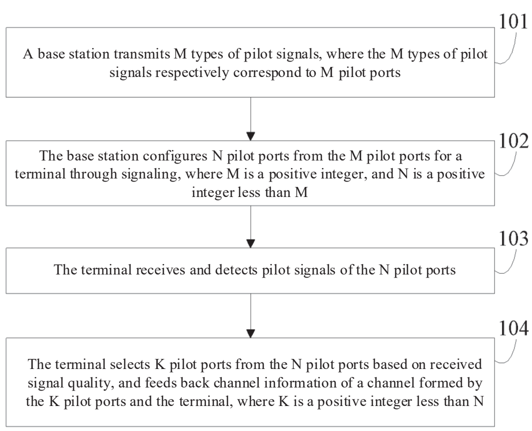
(81) Designated country (unless otherwise specified, each available national protection is required): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, and ZW.

[See Continued Page]

(54) Title: CHANNEL INFORMATION FEEDBACK METHOD, AND PILOT AND BEAM TRANSMISSION METHOD, SYSTEM AND DEVICE

(54) Tile of the invention: CHANNEL INFORMATION FEEDBACK METHOD, PILOT AND BEAM TRANSMISSION METHOD, SYSTEM AND APPARATUS



101 TRANSMITTING, BY A BASE STATION, M TYPES OF PILOT SIGNALS, WHEREIN THE M TYPES OF PILOT SIGNALS RESPECTIVELY CORRESPOND TO M PILOT PORTS

102 CONFIGURING, BY THE BASE STATION, N PILOT PORTS FROM THE M PILOT PORTS TO A TERMINAL THROUGH SIGNALLING, WHERE M IS A POSITIVE INTEGER, AND N IS A POSITIVE INTEGER LESS THAN M

103 RECEIVING AND DETECTING, BY THE TERMINAL, PILOT SIGNALS OF THE N PILOT PORTS

104 ACCORDING TO THE QUALITY OF THE RECEIVED SIGNALS, SELECTING, BY THE TERMINAL, K PILOT PORTS FROM THE N PILOT PORTS, AND FEEDING BACK CHANNEL INFORMATION ABOUT A CHANNEL FORMED BY THE K PILOT PORTS AND THE TERMINAL, WHERE K IS A POSITIVE INTEGER LESS THAN N

(57) Abstract: Disclosed are a channel information feedback method, and a pilot and beam transmission method, system and device. The channel information feedback method comprises: transmitting, by a base station, M types of pilot signals, wherein the M types of pilot signals respectively correspond to M pilot ports; configuring, by the base station, N pilot ports from the M pilot ports to a terminal through signalling, where M is a positive integer, and N is a positive integer less than M; receiving and detecting, by the terminal, pilot signals of the N pilot ports; and according to the quality of the received signals, selecting K pilot ports from the N pilot ports, and feeding back channel information about a channel formed by the K pilot ports and the terminal, where K is a positive integer less than N.

WO 2015/131494 A2

(84) **Designated country** (unless otherwise specified, each available regional protection is required): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, and ZW), Eurasia (AM, AZ, BY, KG, KZ, RU, TJ, and TM), and Europe (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG
CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, and TG).

This International publication:

– Excluding the international search report, which will be re-published upon receipt of the report (Rule 48.2 (g)).

Channel Information Feedback Method, and Pilot and Beam Transmission Method, System and Apparatus

Technical Field

The present invention relates to a channel information feedback technology in communication, and in particular, to a channel information feedback method, and a pilot and beam transmission method, system and apparatus.

Background

In a wireless communication system, a transmit end and a receive end use a spatial multiplexing to obtain a higher data transmission rate by using a plurality of antennas. Compared with a common spatial multiplexing manner, in an enhanced spatial multiplexing manner, the receive end feeds back channel information to the transmit end, and the transmit end transmits data based on the obtained channel information by using a transmit precoding technology, thereby greatly improving transmission performance. For single-user multi-input multi-output (MIMO, Multi-Input Multi-Output), channel feature vector information is directly used for precoding. For multi-user MIMO, more accurate channel information is needed.

In some technologies of the fourth generation of mobile phone mobile communications standards (4G, fourth Generation of mobile phone mobile communications standards), for example, in the long term evolution (LTE, Long Term Evolution) 802.16m standard specification, a relatively simple single codebook feedback method is mainly used for channel information feedback, and performance of a transmit precoding technology of MIMO is more dependent on codebook feedback accuracy. A basic principle of codebook-based quantized channel information feedback is as follows:

Assuming that a limited feedback channel capacity is *B* bps/Hz, a quantity of available codewords is $N = 2^B$. A feature vector space of a channel matrix is quantized to form a codebook space $\Re = \{F_1, F_2 \cdots F_N\}$.The transmit end stores or generates the codebook in real time together with the receive end. The receive end selects, from $\Re$ based on a specific criterion by using an obtained channel matrix H, a codeword $\hat{F}$ that best matches a channel, and feeds back a codeword sequence number *i* to the transmit end.Herein, the codeword sequence number refers to a precoding matrix indicator (PMI, Precoding Matrix Indicator). The transmit end finds the corresponding precoding codeword $\hat{F}$ based on the sequence number *i* to obtain channel information. Herein, $\hat{F}$ indicates feature vector information of the channel.

With the rapid development of wireless communication technologies, wireless applications at a user end are becoming more and more abundant, which drives the rapid growth of wireless data services. However, this also poses a huge challenge to a wireless access network. The multi-antenna technology is a key technology to cope with the explosive growth of wireless data services. Currently, a multi-antenna technology supported by 4G only supports a horizontal beamforming technology with a maximum of 8 ports. Evolution of the multi-antenna technology mainly focuses on the following objectives: ① larger beamforming/precoding gain; ② more spatial multiplexing layers and smaller inter-layer interference; ③ more comprehensive coverage; and ④ smaller inter-site interference. Massive MIMO (Massive MIMO) is the most important technology for MIMO evolution in next-generation wireless communication.

For the Massive MIMO technology, a large-scale antenna array is configured on a base station side, for example, 100 antennas or more antennas are configured. During data transmission, a plurality of users are multiplexed simultaneously at a same frequency by using a multi-user MIMO (MU-MIMO, Multi-User-MIMO) technology. Generally, a quantity of antennas is about 5 to 10 times of a quantity of multiplexed users. Regardless of a strongly correlated channel in a line-of-sight environment or an uncorrelated channel in strong scattering, a correlation coefficient between channels of any two users is exponentially attenuated as the quantity of antennas increases. For example, when 100 antennas are configured on the base station side, the correlation coefficient between the channels of any two users approaches 0, that is, channels corresponding to a plurality of users are nearly orthogonal. In another aspect, a large array can provide a considerable array gain and diversity gain.

For the Massive MIMO technology, a large quantity of antennas are introduced, and each antenna needs to send a channel state information-reference symbol (CSI-RS, Channel State Information-Reference Symbol). A terminal detects the CSI-RS and obtains a channel matrix corresponding to each transmission resource through channel estimation; obtains, based on the channel matrix, a precoding vector of each frequency domain subband on the best baseband and information about the best transmission layer quantity; and then performs feedback based on a codebook feedback technology. In this manner, a relatively large problem exists when the Massive MIMO is used. This is mainly reflected in the following aspects: Pilot overheads increase with an increase in a quantity of antennas. In addition, when feedback is performed by using the conventional codebook feedback technology, a codebook used needs to include a large quantity of codewords. Selection of codewords is very difficult, complexity of the terminal increases, and it is difficult to implement. Codebook feedback overheads are very high, resulting in huge uplink overheads. It is difficult to obtain relatively good performance in a large-scale antenna system by using the codebook feedback technology.

In conclusion, for the large-scale antenna system, channel information feedback efficiency and feedback complexity are important technical problems. Currently, there is no effective method for improving channel information feedback efficiency and reducing feedback complexity, which seriously affects industrial practicality of the Massive MIMO.

Summary

To resolve the foregoing technical problem, examples of the present invention provide a channel information feedback method, and a pilot and beam transmission method, system and apparatus.

A channel information feedback method provided in an example of the present invention comprises: transmitting, by a base station, M types of pilot signals, where the M types of pilot signals respectively correspond to M pilot ports; and configuring, by the base station, N pilot ports from the M pilot ports for a terminal through signaling, where M is a positive integer, and N is a positive integer less than M; and

receiving and detecting, by the terminal, pilot signals of the N pilot ports; and selecting K pilot ports from the N pilot ports based on received signal quality, and feeding back channel information of a channel formed by the K pilot ports and the terminal, where K is a positive integer less than N.

Preferably, the channel information comprises at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the method further comprises:

forming the K pilot ports through virtualization of a same set of antennas, where each of the K pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further comprises:

forming the N pilot ports through virtualization of a same set of antennas, where each of the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further comprises:

determining, by the base station, the N pilot ports based on channel statistical information fed back by the terminal, where the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

Preferably, virtualized precoding weights corresponding to the N pilot ports are DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, where

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f(v_k, v_l) = v_k \otimes v_l \text{ or } f(v_k, v_l) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

where k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

Preferably, the method further comprises:

selecting, by the terminal, the K pilot ports from the N pilot ports based on a power threshold configured by the base station, where the power threshold is a relative threshold or an absolute threshold.

Preferably, the method further comprises:

configuring, by the base station, the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

Preferably, the method further comprises:

feeding back, by the terminal, pilot port selection information, where the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

A pilot transmission method provided in an example of the present invention comprises:

transmitting, by a base station, M types of pilot signals, where the M types of pilot signals respectively correspond to M pilot ports; and configuring, by the base station, N pilot ports from the M pilot ports for a terminal through signaling, where M is a positive integer, and N is a positive integer less than M.

Preferably, the method further comprises:

forming the N pilot ports through virtualization of a same set of antennas, where each of the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further comprises:

determining, by the base station, the N pilot ports based on channel statistical information fed back by the terminal, where the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

Preferably, virtualized precoding weights corresponding to the N pilot ports are discrete Fourier transform DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, where

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f(v_k, v_l) = v_k \otimes v_l \text{ or } f(v_k, v_l) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

where k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

Preferably, the method further comprises:

configuring, by the base station, the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

A channel information feedback method provided in an example of the present invention comprises: receiving and detecting, by a terminal, pilot signals of N pilot ports configured by a base station; and selecting K pilot ports from the N pilot ports based on received signal quality, and feeding back channel information of a channel formed by the K pilot ports and the terminal, where K is a positive integer less than N.

Preferably, the channel information comprises at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the method further comprises:

selecting, by the terminal, the K pilot ports from the N pilot ports based on a power threshold configured by the base station, where the power threshold is a relative threshold or an absolute threshold.

Preferably, the method further comprises:

feeding back, by the terminal, pilot port selection information, where the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

Preferably, the method further comprises:

forming the K pilot ports through virtualization of a same set of antennas, where each of the K pilot ports corresponds to a set of virtualized precoding weights.

A beam transmission method provided in an example of the present invention comprises:

pre-selecting, by a base station, P beam weights, and processing the P beam weights based on a channel correlation matrix fed back by a terminal, to obtain P new beams; and sending the P new beams to the terminal; and

selecting, by the terminal, Q beams from the P new beams, and feeding back the Q beams to the base station.

Preferably, the channel correlation matrix is obtained by superposing and combining correlation matrix information of a plurality of terminals.

Preferably, the P beam weights are P DFT vectors or a function of two DFT vectors.

A channel information feedback system provided in an example of the present invention comprises a base station and a terminal.

The base station is configured to: transmit M types of pilot signals, where the M types of pilot signals respectively correspond to M pilot ports; and configure N pilot ports from the M pilot ports for the terminal through signaling, where M is a positive integer, and N is a positive integer less than M.

The terminal is configured to: receive and detect pilot signals of the N pilot ports; and select K pilot ports from the N pilot ports based on received signal quality, and feed back channel information of a channel formed by the K pilot ports and the terminal, where K is a positive integer less than N.

Preferably, the channel information comprises at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the terminal is further configured to form the K pilot ports through virtualization of a same set of antennas, where each of the K pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the base station is further configured to form the N pilot ports through virtualization of a same set of antennas, where each of the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the base station is further configured to determine the N pilot ports based on channel statistical information fed back by the terminal, where the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

Preferably, virtualized precoding weights corresponding to the N pilot ports are discrete Fourier transform DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, where

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f(v_k, v_l) = v_k \otimes v_l \text{ or } f(v_k, v_l) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

where k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

Preferably, the terminal is further configured to select the K pilot ports from the N pilot ports based on a power threshold configured by the base station, where the power threshold is a relative threshold or an absolute threshold.

Preferably, the base station is further configured to configure the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

Preferably, the terminal is further configured to feed back pilot port selection information, where the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

A base station provided in an example of the present invention comprises a transmission unit and a configuration unit.

The transmission unit is configured to transmit M types of pilot signals, where the M types of pilot signals respectively correspond to M pilot ports.

The configuration unit is configured to configure N pilot ports from the M pilot ports for a terminal through signaling, where M is a positive integer, and N is a positive integer less than M.

Preferably, the base station further comprises a virtualization unit, configured to form the N pilot ports through virtualization of a same set of antennas, where each of the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the configuration unit is further configured to determine the N pilot ports based on channel statistical information fed back by the terminal, where the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

Preferably, virtualized precoding weights corresponding to the N pilot ports are discrete Fourier transform DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, where

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f(v_k, v_l) = v_k \otimes v_l \text{ or } f(v_k, v_l) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

where k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

Preferably, the configuration unit is further configured to configure the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

A terminal provided in an example of the present invention comprises a receiving unit, a selection unit, and a feedback unit.

The receiving unit is configured to receive and detect pilot signals of N pilot ports configured by a base station.

The selection unit is configured to select K pilot ports from the N pilot ports based on received signal quality.

The feedback unit is configured to feed back channel information of a channel formed by the K pilot ports and the terminal, where K is a positive integer less than N.

Preferably, the channel information comprises at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the selection unit is further configured to select the K pilot ports from the N pilot ports based on a power threshold configured by the base station, where the power threshold is a relative threshold or an absolute threshold.

Preferably, the feedback unit is further configured to feed back pilot port selection information, where the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

Preferably, the terminal further comprises a virtualization unit, configured to form the K pilot ports through virtualization of a same set of antennas, where each of the K pilot ports corresponds to a set of virtualized precoding weights.

A beam transmission system provided in an example of the present invention comprises a base station and a terminal.

The base station is configured to: pre-select P beam weights, and process the P beam weights based on a channel correlation matrix fed back by the terminal, to obtain P new beams; and send the P new beams to the terminal.

The terminal is configured to select Q beams from the P new beams, and feed back the Q beams to the base station.

Preferably, the channel correlation matrix is obtained by superposing and combining correlation matrix information of a plurality of terminals.

Preferably, the P beam weights are P DFT vectors or a function of two DFT vectors.

In the technical solutions of the examples of the present invention, the base station transmits the M types of pilot signals, where the M types of pilot signals respectively correspond to the M pilot ports; and the base station configures the N pilot ports from the M pilot ports for the terminal through signaling, where M is a positive integer, and N is a positive integer less than M. In this way, the dimension of channel information of the M pilot ports is reduced to the dimension of channel information of the N pilot ports, so that the terminal can select the K pilot ports from the N pilot ports to perform channel information feedback in a subspace determined based on correlation. In addition, the terminal selects the K pilot ports from the N pilot ports to perform channel information feedback, which can further reduce the dimension of channel information, thereby greatly reducing overheads of channel information feedback.

Description of Drawings

FIG. 1 is a schematic flowchart of a channel information feedback method according to Example 1 of the present invention;

FIG. 2 is a schematic flowchart of a pilot transmission method according to Example 2 of the present invention;

FIG. 3 is a schematic flowchart of a channel information feedback method according to Example 3 of the present invention;

FIG. 4 is a schematic flowchart of a beam transmission method according to Example 4 of the present invention;

FIG. 5 is a schematic diagram of structural composition of a channel information feedback system according to Example 1 of the present invention;

FIG. 6 is a schematic diagram of structural composition of a base station according to Example 2 of the present invention;

FIG. 7 is a schematic diagram of structural composition of a terminal according to Example 3 of the present invention;

FIG. 8 is a schematic diagram of structural composition of a beam transmission system according to Example 4 of the present invention;

FIG. 9 is a schematic diagram of base station precoding according to an example of the present invention;

FIG. 10 is a schematic diagram of DFT vector precoding according to an example of the present invention;

FIG. 11 is a schematic diagram of channel correlation matrix precoding according to an example of the present invention; and

FIG. 12 is a schematic diagram of channel information feedback based on a beam weight according to an example of the present invention.

Description of Embodiments

To understand features and technical content of the examples of the present invention in more detail, the following describes implementation of the examples of the present invention in detail with reference to the accompanying drawings. The accompanying drawings are merely used for reference and description, and are not intended to limit the examples of the present invention.

FIG. 1 is a schematic flowchart of a channel information feedback method according to Example 1 of the present invention. The channel information feedback method in this example is applied to a channel information feedback system. As shown in FIG. 1, the channel information feedback method in this example includes the following steps:

Step 101: Transmitting, by a base station, M types of pilot signals, where the M types of pilot signals respectively correspond to M pilot ports.

Herein, M is an integer greater than 1. For example, M is 64.

Specifically, referring to FIG. 9, the base station has Nt same transmit antennas, where Nt is an integer greater than 1. Each transmit antenna transmits one signal, and the Nt transmit antennas transmit Nt signals. In this example, the Nt signals transmitted by the Nt transmit antennas are virtualized to obtain the M types of pilot signals. Herein, virtualization is specifically precoding, that is, the Nt signals are respectively multiplied by corresponding Nt weights to obtain a type of pilot signal. Based on this, the Nt weights form a set of weight vectors, and the dimension is Nt. Each type of pilot signal corresponds to a different set of weight vectors, that is, the M types of pilot signals correspond to M sets of weight vectors. It should be noted that because a weight vector has a direction, a pilot signal precoded by using the weight vector also has a direction.

Step 102: Configuring, by the base station, N pilot ports from the M pilot ports for a terminal through signaling, where M is a positive integer, and N is a positive integer less than M.

Preferably, the method further includes:

configuring, by the base station, the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

Preferably, the method further includes:

forming the N pilot ports through virtualization of a same set of antennas, where each of the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further includes:

determining, by the base station, the N pilot ports based on channel statistical information fed back by the terminal, where the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

Preferably, virtualized precoding weights corresponding to the N pilot ports are discrete Fourier transform (DFT, Discrete Fourier Transform) vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, where

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f\left(v_k, v_l\right) = v_k \otimes v_l \text{ or } f\left(v_k, v_l\right) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

where k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

Specifically, referring to FIG. 10, a preset beam weight may be a DFT vector, M DFT vectors corresponding to the M types of pilot signals, that is, the M pilot ports, are shown in Formula (1):

$$\begin{aligned} \mathbf{v_1} &= \begin{bmatrix} 1 & e^{j\phi_1} & \cdots & e^{j(P1-1)\phi_1} \end{bmatrix}^H \\ \mathbf{v_2} &= \begin{bmatrix} 1 & e^{j\phi_2} & \cdots & e^{j(P2-1)\phi_2} \end{bmatrix}^H \\ &\cdots \\ \mathbf{v_M} &= \begin{bmatrix} 1 & e^{j\phi_M} & \cdots & e^{j(PM-1)\phi_M} \end{bmatrix}^H \end{aligned} \qquad (1)$$

where $\mathbf{v_1}$, $\mathbf{v_2}$, $\cdots$, $\mathbf{v_M}$ represent the M DFT vectors, $P1$, $P2$, $\cdots$, PM all are equal to Nt; ϕ_1, ϕ_2, $\cdots$, ϕ_M are uniformly quantized phase parameters in 0 to 2π, and $[\quad \cdots \quad]^H$ represents a transpose conjugate.

The foregoing DFT vector uses a multi-path principle, that is, the DFT vector is used to correspond to an optimal beam weight of the path. Because a channel is synthesized by a plurality of paths, for the M types of pilot signals, some pilot ports receive relatively strong pilot signals, where receiving a relatively strong pilot signal means that a multi-path component is relatively strong; and some pilot ports receive relatively weak pilot signals, where receiving a relatively weak pilot signal means that a multi-path component is relatively weak.

In the foregoing solution, the Nt transmit antennas are in a linear array. When the Nt transmit antennas are in another form of antenna array, for example, a two-dimensional antenna array, beam weights corresponding to the M pilot signals are in a form of a function of two DFT vectors, for example, as shown in Formula (2):

$$f\left(\mathbf{v_i}, \mathbf{v_j}\right) = \mathbf{v_i} \otimes \mathbf{v_j} \qquad (2)$$

where $\mathbf{v_i}$ and $\mathbf{v_j}$ are shown in Formula (1), and Pi corresponding to $\mathbf{v_i}$ multiplied by Pj corresponding to $\mathbf{v_j}$ equals the quantity Nt of transmit antennas.

The beam weights corresponding to the M pilot signals in the two-dimensional antenna array may alternatively be obtained by using Formula (3):

$$f\left(\mathbf{v}_{i}, \mathbf{v}_{j}\right)=\begin{bmatrix}\mathbf{v}_{i} \\ \mathbf{v}_{j}\end{bmatrix} \quad (3)$$

where $\mathbf{v}_i$ and $\mathbf{v}_j$ are shown in Formula (1), and both Pi corresponding to $\mathbf{v}_i$ and Pj corresponding to $\mathbf{v}_j$ are equal to half Nt/2 of the quantity of transmit antennas.

Herein, not all terminals need to detect the M pilot ports corresponding to the M types of pilot signals. The base station may configure some ports for each terminal for detection. For example, N1=16 pilot ports may be configured for a user equipment (UE, User Equipment) 1 for detection, and N2=8 pilot ports may be configured for a UE 2 for detection. A specific pilot port may be determined by the base station based on location information of the terminal or some coarse channel information reported by the terminal.

Step 103: Receiving and detecting, by the terminal, pilot signals of the N pilot ports.

Specifically, the base station sends port information of the N pilot ports for the terminal. In addition, the terminal detects N types of pilot signals of the N pilot ports based on the port information, to obtain received power corresponding to the N types of pilot signals. The terminal selects K pilot ports from the N pilot ports based on the received power corresponding to the N types of pilot signals. The terminal sends channel information of the K pilot ports to the base station.

Specifically, the terminal receives the port information of the N pilot ports that is sent by the base station. Herein, the base station selects the N pilot ports from the generated M pilot ports based on location information or channel information of the terminal, where $N<M$.

Step 104: Selecting, by the terminal, K pilot ports from the N pilot ports based on received signal quality, and feeding back channel information of a channel formed by the K pilot ports and the terminal, where K is a positive integer less than N.

Preferably, the method further includes:

selecting, by the terminal, the K pilot ports from the N pilot ports based on a power threshold configured by the base station, where the power threshold is a relative threshold or an absolute threshold.

After obtaining the port information sent by the base station, the terminal detects a pilot signal at a corresponding port location, to obtain the received power corresponding to the N types of pilot signals. Specifically, when N is 8,

the terminal detects that received power of a pilot signal 0 is a_0 dBm;

the terminal detects that received power of a pilot signal 1 is a_1 dBm;

the terminal detects that received power of a pilot signal 2 is a_2 dBm;

…

the terminal detects that received power of a pilot signal 7 is a_7 dBm.

Preferably, the channel information includes at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

Specifically, the received power corresponding to the N types of pilot signals is separately compared with a preset threshold.

When the received power is greater than or equal to the threshold, it is determined that a pilot port corresponding to the received power is a first-type port.

When the received power is less than the threshold, it is determined that a pilot port corresponding to the received power is a second-type port.

The first-type port is selected from the N pilot ports, where a quantity of first-type ports is K.

Alternatively, maximum received power is determined from the received power corresponding to the N types of pilot signals.

The received power corresponding to the N types of pilot signals is separately compared with the maximum received power.

When the ratio of the received power to the maximum received power is greater than or equal to a preset threshold, it is determined that a pilot port corresponding to the received power is a first-type port.

When the ratio of the received power to the maximum received power is less than the threshold, it is determined that a pilot port corresponding to the received power is a second-type port.

The first-type port is selected from the N pilot ports, where a quantity of first-type ports is K.

Preferably, the base station presets a maximum quantity of pilot ports, where K is less than or equal to the maximum quantity of pilot ports.

In the foregoing solution, two selection manners of selecting the K pilot ports from the N pilot ports may be combined, which is specifically as follows: When received power of a pilot signal of a selected pilot port is greater than or equal to the threshold, and when the ratio of the received power of the pilot signal of the selected pilot port to the maximum received power is greater than or equal to the preset threshold, the pilot port is the first-type port.

Preferably, the method further includes:

forming the K pilot ports through virtualization of a same set of antennas, where each of the K pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further includes:

feeding back, by the terminal, pilot port selection information, where the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

In this example, after the K pilot ports are selected from the N pilot ports, selection information of the K pilot ports is further reported. Specifically, the pilot ports have different probabilities of being selected, selection probabilities of some pilot ports are high, and selection probabilities of some pilot ports are low. Therefore, a probability of a pilot port may be represented by using a code. For example, K=2 pilot ports are selected from N=8 pilot ports. Coding information is shown in Table 1.

0000	Port 1, Port 2	1000	Port 2, Port 4
0001	Port 1, Port 3	1001	Port 2, Port 5
0010	Port 1, Port 4	1010	Port 2, Port 6
0011	Port 1, Port 5	1011	Port 2, Port 7
0100	Port 1, Port 6	1100	Port 2, Port 8
0101	Port 1, Port 7	1101	Port 3, Port 4
0110	Port 1, Port 8	1110	Port 3, Port 5
0111	Port 2, Port 3	1111	Port 4, Port 5

Table 1

For example, K=3 pilot ports are selected from N=8 pilot ports. Coding information is shown in Table 2.

0000	Port 1, Port 2, Port 3	1000	Port 1, Port 3, Port 6
0001	Port 1, Port 2, Port 4	1001	Port 1, Port 3, Port 7
0010	Port 1, Port 2, Port 5	1010	Port 1, Port 3, Port 8
0011	Port 1, Port 2, Port 6	1011	Port 2, Port 3, Port 4
0100	Port 1, Port 2, Port 7	1100	Port 2, Port 3, Port 5

0101	Port 1, Port 2, Port 8	1101	Port 2, Port 3, Port 6
0110	Port 1, Port 3, Port 4	1110	Port 2, Port 3, Port 7
0111	Port 1, Port 3, Port 5	1111	Port 2, Port 3, Port 8

Table 2

In addition, considering that quantities of selected pilot ports are also have unequal probabilities, for example, a probability of a quantity of selected pilot ports being 2 is different from a probability of a quantity of selected pilot ports being 4, joint coding may also be performed between a quantity of pilot ports and a probability of a pilot port to compress coding overheads. Coding information is shown in Table 3.

0000	Port 1, Port 2	1000	Port 2, Port 4
0001	Port 1, Port 3	1001	Port 3, Port 4
0010	Port 1, Port 4	1010	Port 3, Port 5
0011	Port 1, Port 5	1011	Port 4, Port 5
0100	Port 1, Port 6	1100	Port 1, Port 2, Port 3
0101	Port 1, Port 7	1101	Port 1, Port 2, Port 4
0110	Port 1, Port 8	1110	Port 1, Port 3, Port 4
0111	Port 2, Port 3	1111	Port 2, Port 3, Port 4

Table 3

The phase difference information is obtained by calculating a phase difference after beam signals received by the receive antennas are averaged.

Specifically, for a selected pilot port, the terminal feeds back amplitude/power information and phase information of the pilot port. It is preferable herein to feed back relative information between pilot ports, such as an amplitude/power ratio and phase difference information. The amplitude/power ratio may be in the following manner: A pilot port with the strongest power is indicated, and the ratio related to an amplitude or power of the pilot port with the strongest power is fed back. Specifically, as shown in Table 4, a magnitude level of an amplitude or power is first indicated, and then a coefficient at the magnitude level is indicated. The coefficient may be uniformly quantized. The phase difference information may be uniformly quantized in 0 to 2π and fed back

00	$10^{-0.5}$
01	10^{-1}
10	$10^{-1.5}$
11	10^{-2}

Table 4

Herein, when the beam weight is a DFT vector, the received power information and the phase difference information are specifically multi-path amplitude and phase difference information. Based on the received channel information, the base station may reconstruct the beam weight to optimize precoding.

FIG. 2 is a schematic flowchart of a pilot transmission method according to Example 2 of the present invention. The pilot transmission method in this example is applied to a base station. As shown in FIG. 2, the pilot transmission method in this example includes the following steps:

Step 201: Transmitting, by the base station, M types of pilot signals, where the M types of pilot signals respectively correspond to M pilot ports.

Step 202: Configuring, by the base station, N pilot ports from the M pilot ports for a terminal through signaling, where M is a positive integer, and N is a positive integer less than M.

Preferably, the method further includes:

forming the N pilot ports through virtualization of a same set of antennas, where each of the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further includes:

determining, by the base station, the N pilot ports based on channel statistical information fed back by the terminal, where the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

Preferably, virtualized precoding weights corresponding to the N pilot ports are discrete Fourier transform DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, where

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f\left(v_k, v_l\right) = v_k \otimes v_l \text{ or } f\left(v_k, v_l\right) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

where k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

Preferably, the method further includes:

configuring, by the base station, the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

FIG. 3 is a schematic flowchart of a channel information feedback method according to Example 3 of the present invention. The channel information feedback method in this example is applied to a terminal. As shown in FIG. 3, the channel information feedback method in this example includes the following steps:

Step 301: Receiving and detecting, by the terminal, pilot signals of N pilot ports configured by a base station.

Step 302: Selecting K pilot ports from the N pilot ports based on received signal quality.

Preferably, the method further includes:

selecting, by the terminal, the K pilot ports from the N pilot ports based on a power threshold configured by the base station, where the power threshold is a relative threshold or an absolute threshold.

Step 303: Feeding back channel information of a channel formed by the K pilot ports and the terminal, where K is a positive integer less than N.

Preferably, the channel information includes at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the method further includes:

feeding back, by the terminal, pilot port selection information, where the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

Preferably, the method further includes:

forming the K pilot ports through virtualization of a same set of antennas, where each of the K pilot ports corresponds to a set of virtualized precoding weights.

FIG. 4 is a schematic flowchart of a beam transmission method according to Example 4 of the present invention. The beam transmission method in this example is applied to a beam transmission system. As shown in FIG. 4, the beam transmission method in this example includes the following steps:

Step 401: Pre-selecting, by a base station, P beam weights, and processing the P beam weights based on a channel correlation matrix fed back by a terminal, to obtain P new beams; and sending the P new beams to the terminal.

Preferably, the channel correlation matrix is obtained by superposing and combining correlation matrix information of a plurality of terminals.

Specifically, one or more received channel correlation submatrices are superposed to obtain the channel correlation matrix.

Signals corresponding to a plurality of transmit antennas are precoded based on feature vectors of the channel correlation matrix to obtain M types of pilot signals.

Specifically, referring to FIG. 11, a preset beam weight may alternatively be a channel correlation matrix **R**. The base station receives a channel correlation submatrix fed back by one or more UEs, and superposes one or more channel correlation submatrices to obtain the channel correlation matrix **R**. Herein, the channel correlation submatrix is channel correlation matrix information of the terminal, for example, information about each element in the channel correlation matrix **R**, eigenvalue information of the channel correlation matrix **R**, and feature vector information of the channel correlation matrix **R**.

When the beam weight is the channel correlation matrix **R**, the base station superposes the correlation matrix **R** based on received channel information sent by one or more terminal, to reconstruct the beam weight and further optimize precoding.

Specifically, referring to FIG. 12, the base station pre-selects P beam weights, where the P beam weights may be some relatively uniform weights, that is, a chord distance needs to be greater than a threshold, for example, 0.9. The selected P beam weights may be some DFT vectors, or may be uniform vectors in some Nt-dimensional spaces generated by using the Grassmanian (Grassmanian) method.

The terminal feeds back a channel correlation submatrix corresponding to the terminal. The channel correlation submatrix is obtained through measurement by the terminal. The base station may use a channel correlation submatrix of one terminal or a superposition value **R** of channel correlation submatrices of a plurality of terminals as a beam weight rotation matrix, multiply the beam weight rotation matrix by the selected P beam weights, and then perform normalized power processing.

After rotation is performed, distribution of uniform P beams is adjusted based on correlation in **R**, where some subspaces have relatively dense beams, and some subspaces have relatively sparse beams. However, feature vectors of the terminal are more in a subspace with relatively dense beams.

The terminal selects, from a received pilot signal, information corresponding to one optical pilot port or a plurality of pilot ports, and reports the information to the base station. The base station may find, based on the port information reported by the terminal, a corresponding pilot port and a corresponding beam weight, and perform precoding by using the beam weight.

Preferably, the P beam weights are P DFT vectors or a function of two DFT vectors.

Step 402: Selecting, by the terminal, Q beams from the P new beams, and feeding back the Q beams to the base station.

FIG. 5 is a schematic diagram of structural composition of a channel information feedback system according to Example 1 of the present invention. As shown in FIG. 5, the system includes a base station 51 and a terminal 52.

The base station 51 is configured to: transmit M types of pilot signals, where the M types of pilot signals respectively correspond to M pilot ports; and configure N pilot ports from the M pilot ports for the terminal 52 through signaling, where M is a positive integer, and N is a positive integer less than M.

The terminal 52 is configured to: receive and detect pilot signals of the N pilot ports; and select K pilot ports from the N pilot ports based on received signal quality, and feed back channel information of a channel formed by the K pilot ports and the terminal 52, where K is a positive integer less than N.

Preferably, the channel information includes at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the terminal 52 is further configured to form the K pilot ports through virtualization of a same set of antennas, where each of the K pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the base station 51 is further configured to form the N pilot ports through virtualization of a same set of antennas, where each of the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the base station 51 is further configured to determine the N pilot ports based on channel statistical information fed back by the terminal 52, where the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

Preferably, virtualized precoding weights corresponding to the N pilot ports are discrete Fourier transform DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, where

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f(v_k, v_l) = v_k \otimes v_l \text{ or } f(v_k, v_l) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

where k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

Preferably, the terminal 52 is further configured to select the K pilot ports from the N pilot ports based on a power threshold configured by the base station 51, where the power threshold is a relative threshold or an absolute threshold.

Preferably, the base station 51 is further configured to configure the N pilot ports from the M pilot ports for the terminal 52 based on terminal 52 information reported by the terminal 52.

Preferably, the terminal 52 is further configured to feed back pilot port selection information, where the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

A person skilled in the art should understand that, for implementation functions of the base station 51 and the terminal 52 in the channel information feedback system shown in FIG. 5, refer to related descriptions of the foregoing channel information feedback method for understanding.

FIG. 6 is a schematic diagram of structural composition of a base station according to Example 2 of the present invention. As shown in FIG. 6, the base station includes a transmission unit 61 and a configuration unit 62.

The transmission unit 61 is configured to transmit M types of pilot signals, where the M types of pilot signals respectively correspond to M pilot ports.

The configuration unit 62 is configured to configure N pilot ports from the M pilot ports for a terminal through signaling, where M is a positive integer, and N is a positive integer less than M.

Preferably, the base station further includes a virtualization unit 63, configured to form the N pilot ports through virtualization of a same set of antennas, where each of the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the configuration unit 62 is further configured to determine the N pilot ports based on channel statistical information fed back by the terminal, where the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

Preferably, virtualized precoding weights corresponding to the N pilot ports are discrete Fourier transform DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, where

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f(v_k, v_l) = v_k \otimes v_l \text{ or } f(v_k, v_l) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

where k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

Preferably, the configuration unit 62 is further configured to configure the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

A person skilled in the art should understand that, for implementation functions of units in the base station shown in FIG. 6, refer to related descriptions of the foregoing pilot transmission method for understanding.

In actual application, the transmission unit 61, the configuration unit 62, and the virtualization unit 63 in the base station may be implemented by a central processing unit (CPU, Central Processing Unit), a digital signal processor (DSP, Digital Signal Processor), or a programmable gate array (FPGA, Field-Programmable Gate Array) in the base station.

FIG. 7 is a schematic diagram of structural composition of a terminal according to Example 3 of the present invention. As shown in FIG. 7, the terminal includes a receiving unit 71, a selection unit 72, and a feedback unit 73.

The receiving unit 71 is configured to receive and detect pilot signals of N pilot ports configured by a base station.

The selection unit 72 is configured to select K pilot ports from the N pilot ports based on received signal quality.

The feedback unit 73 is configured to feed back channel information of a channel formed by the K pilot ports and the terminal, where K is a positive integer less than N.

Preferably, the channel information includes at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the selection unit 72 is further configured to select the K pilot ports from the N pilot ports based on a power threshold configured by the base station, where the power threshold is a relative threshold or an absolute threshold.

Preferably, the feedback unit 73 is further configured to feed back pilot port selection information, where the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

Preferably, the terminal further includes a virtualization unit 74, configured to form the K pilot ports through virtualization of a same set of antennas, where each of the K pilot ports corresponds to a set of virtualized precoding weights.

A person skilled in the art should understand that, for implementation functions of units in the terminal shown in FIG. 7, refer to related descriptions of the foregoing channel information feedback method for understanding.

In actual application, the receiving unit 71, the selection unit 72, the feedback unit 73, and the virtualization unit 74 in the terminal may be implemented by a CPU, a DSP, or an FPGA in the terminal.

FIG. 8 is a schematic diagram of structural composition of a beam transmission system according to Example 4 of the present invention. As shown in FIG. 8, the system includes a base station 81 and a terminal 82.

The base station 81 is configured to: pre-select P beam weights, and process the P beam weights based on a channel correlation matrix fed back by the terminal 82, to obtain P new beams; and send the P new beams to the terminal 82.

The terminal 82 is configured to select Q beams from the P new beams, and feed back the Q beams to the base station 81.

Preferably, the channel correlation matrix is obtained by superposing and combining correlation matrix information of a plurality of terminals 82.

Preferably, the P beam weights are P DFT vectors or a function of two DFT vectors.

A person skilled in the art should understand that, for implementation functions of the base station 81 and the terminal 82 in the beam transmission system shown in FIG. 8, refer to related descriptions of the foregoing beam transmission method for understanding.

In the several examples provided in this application, it should be understood that the disclosed device and method may be implemented in other manners. The device examples described above are merely examples. For example, division into the units is merely logical function division, and there may be another division manner in actual implementation. For example, a plurality of units or components may be combined or integrated into another system, or some features may be ignored or not performed. In addition, the displayed or discussed mutual couplings or direct couplings or communication connections between the components may be implemented through some interfaces. The indirect couplings or communication connections between the devices or units may be implemented in an electrical form, a mechanical form, or another form.

The units described as separate parts may or may not be physically separate, and parts displayed as units may or may not be physical units, that is, may be located in one place, or may be distributed on a plurality of network units. Some or all of the units may be selected based on actual requirements to implement the objectives of the solutions in the examples.

In addition, functional units in the examples of the present invention may be integrated into one processing unit, or each of the units may be separately used as one unit, or two or more units may be integrated into one unit. The integrated unit may be implemented in a form of hardware, or may be implemented in a form of hardware plus a software functional unit.

A person of ordinary skill in the art may understand that all or some of the steps in the foregoing method examples may be implemented by program instructing related hardware. The program may be stored in a computer-readable storage medium. When the program is executed, the steps in the foregoing method examples are performed. The foregoing storage medium includes any medium that can store program code, such as a mobile storage device, a read only memory (ROM, Read Only Memory), a magnetic disk, or an optical disc.

Alternatively, if the integrated unit in the present invention is implemented in a form of a software functional module and sold or used as an independent product, the integrated unit may also be stored in a computer-readable storage medium. Based on such an understanding, the technical solutions in the examples of the present invention essentially or the part contributing to the conventional technology may be implemented in a form of a software product. The computer software product is stored in a storage medium and includes several instructions for instructing a computer device (which may be a personal computer, a server, a network device, or the like) to perform all or some of the steps in the methods in the examples of the present invention. The foregoing storage medium includes any medium that can store program code, such as a mobile storage device, a read only memory (ROM, Read Only Memory), a magnetic disk, or an optical disc.

The foregoing descriptions are merely specific embodiments of the present invention, but are not intended to limit the protection scope of the present invention. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in the present invention shall fall within the protection scope of the present invention. Therefore, the protection scope of the present invention shall be subject to the protection scope of the claims.

The foregoing descriptions are merely preferred examples of the present invention, but are not intended to limit the protection scope of the present invention.

Claims

1. A channel information feedback method, characterized by comprising:

transmitting, by a base station, M types of pilot signals, wherein the M types of pilot signals respectively correspond to M pilot ports; and configuring, by the base station, N pilot ports from the M pilot ports for a terminal through signaling, wherein M is a positive integer, and N is a positive integer less than M; and

receiving and detecting, by the terminal, pilot signals of the N pilot ports; and selecting K pilot ports from the N pilot ports based on received signal quality, and feeding back channel information of a channel formed by the K pilot ports and the terminal, wherein K is a positive integer less than N.

2. The channel information feedback method according to claim 1, wherein the channel information comprises at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

3. The channel information feedback method according to claim 1, wherein the method further comprises:

forming the K pilot ports through virtualization of a same set of antennas, wherein each of the K pilot ports corresponds to a set of virtualized precoding weights.

4. The channel information feedback method according to claim 1, wherein the method further comprises:

forming the N pilot ports through virtualization of a same set of antennas, wherein each of the N pilot ports corresponds to a set of virtualized precoding weights.

5. The channel information feedback method according to claim 4, wherein the method further comprises:

determining, by the base station, the N pilot ports based on channel statistical information fed back by the terminal, wherein the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

6. The channel information feedback method according to claim 1, wherein virtualized precoding weights corresponding to the N pilot ports are discrete Fourier transform DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f\left(v_k, v_l\right) = v_k \otimes v_l \text{ or } f\left(v_k, v_l\right) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

wherein k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

7. The channel information feedback method according to claim 1, wherein the method further comprises:

selecting, by the terminal, the K pilot ports from the N pilot ports based on a power threshold configured by the base station, wherein the power threshold is a relative threshold or an absolute threshold.

8. The channel information feedback method according to claim 1, wherein the method further comprises:

configuring, by the base station, the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

9. The channel information feedback method according to any one of claims 1 to 8, wherein the method further comprises:

feeding back, by the terminal, pilot port selection information, wherein the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

10. A pilot transmission method, characterized by comprising:

transmitting, by a base station, M types of pilot signals, wherein the M types of pilot signals respectively correspond to M pilot ports; and configuring, by the base station, N pilot ports from the M pilot ports for a terminal through signaling, wherein M is a positive integer, and N is a positive integer less than M.

11. The pilot transmission method according to claim 10, wherein the method further comprises:

forming the N pilot ports through virtualization of a same set of antennas, wherein each of the N pilot ports corresponds to a set of virtualized precoding weights.

12. The pilot transmission method according to claim 10, wherein the method further comprises:

determining, by the base station, the N pilot ports based on channel statistical information fed back by the terminal, wherein the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

13. The pilot transmission method according to claim 10, wherein virtualized precoding weights

corresponding to the N pilot ports are discrete Fourier transform DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f(v_k, v_l) = v_k \otimes v_l \text{ or } f(v_k, v_l) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

wherein k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

14. The pilot transmission method according to any one of claims 10 to 13, wherein the method further comprises:

configuring, by the base station, the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

15. A channel information feedback method, characterized by comprising:

receiving and detecting, by a terminal, pilot signals of N pilot ports configured by a base station; and selecting K pilot ports from the N pilot ports based on received signal quality, and feeding back channel information of a channel formed by the K pilot ports and the terminal, wherein K is a positive integer less than N.

16. The channel information feedback method according to claim 15, wherein the channel information comprises at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

17. The channel information feedback method according to claim 15, wherein the method further comprises:

selecting, by the terminal, the K pilot ports from the N pilot ports based on a power threshold configured by the base station, wherein the power threshold is a relative threshold or an absolute threshold.

18. The channel information feedback method according to claim 15, wherein the method further comprises:

feeding back, by the terminal, pilot port selection information, wherein the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

19. The channel information feedback method according to any one of claims 15 to 18, wherein the method further comprises:

forming the K pilot ports through virtualization of a same set of antennas, wherein each of the K pilot ports corresponds to a set of virtualized precoding weights.

20. A beam transmission method, characterized by comprising:

pre-selecting, by a base station, P beam weights, and processing the P beam weights based on a channel correlation matrix fed back by a terminal, to obtain P new beams; and sending the P new beams to the terminal; and

selecting, by the terminal, Q beams from the P new beams, and feeding back the Q beams to the base station.

21. The beam transmission method according to claim 20, wherein the channel correlation matrix is obtained by superposing and combining correlation matrix information of a plurality of terminals.

22. The beam transmission method according to claim 20 or 21, wherein the P beam weights are P DFT vectors or a function of two DFT vectors.

23. A channel information feedback system, characterized by comprising a base station and a terminal, wherein

the base station is configured to: transmit M types of pilot signals, wherein the M types of pilot signals respectively correspond to M pilot ports; and configure N pilot ports from the M pilot ports for the terminal through signaling, wherein M is a positive integer, and N is a positive integer less than M; and

the terminal is configured to: receive and detect pilot signals of the N pilot ports; and select K pilot ports from the N pilot ports based on received signal quality, and feed back channel information of a channel formed by the K pilot ports and the terminal, wherein K is a positive integer less than N.

24. The channel information feedback system according to claim 23, wherein the channel information comprises at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

25. The channel information feedback system according to claim 23, wherein the terminal is further configured to form the K pilot ports through virtualization of a same set of antennas, wherein each of the K pilot ports corresponds to a set of virtualized precoding weights.

26. The channel information feedback system according to claim 23, wherein the base station is further configured to form the N pilot ports through virtualization of a same set of antennas, wherein

each of the N pilot ports corresponds to a set of virtualized precoding weights.

27. The channel information feedback system according to claim 26, wherein the base station is further configured to determine the N pilot ports based on channel statistical information fed back by the terminal, wherein the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

28. The channel information feedback system according to claim 23, wherein virtualized precoding weights corresponding to the N pilot ports are discrete Fourier transform DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f(v_k, v_l) = v_k \otimes v_l \text{ or } f(v_k, v_l) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

wherein k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

29. The channel information feedback system according to claim 23, wherein the terminal is further configured to select the K pilot ports from the N pilot ports based on a power threshold configured by the base station, wherein the power threshold is a relative threshold or an absolute threshold.

30. The channel information feedback system according to claim 23, wherein the base station is further configured to configure the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

31. The channel information feedback system according to any one of claims 23 to 30, wherein the terminal is further configured to feed back pilot port selection information, wherein the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

32. A base station, characterized by comprising a transmission unit and a configuration unit, wherein the transmission unit is configured to transmit M types of pilot signals, wherein the M types of pilot signals respectively correspond to M pilot ports; and

the configuration unit is configured to configure N pilot ports from the M pilot ports for a terminal through signaling, wherein M is a positive integer, and N is a positive integer less than M.

33. The base station according to claim 32, wherein the base station further comprises a virtualization

unit, configured to form the N pilot ports through virtualization of a same set of antennas, wherein each of the N pilot ports corresponds to a set of virtualized precoding weights.

34. The base station according to claim 32, wherein the configuration unit is further configured to determine the N pilot ports based on channel statistical information fed back by the terminal, wherein the channel statistical information is correlation matrix information, and virtualized precoding weights corresponding to the N pilot ports are correlation matrix feature vectors.

35. The base station according to claim 32, wherein virtualized precoding weights corresponding to the N pilot ports are discrete Fourier transform DFT vectors v_k or a Kronecker product $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = \begin{bmatrix} 1 & e^{j\phi_k} & \cdots & e^{j(n-1)\phi_k} \end{bmatrix}^H$$

$$f(v_k, v_l) = v_k \otimes v_l \text{ or } f(v_k, v_l) = \begin{bmatrix} v_k \\ v_l \end{bmatrix}$$

wherein k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, ϕ_k is a phase parameter, $[\ ]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct multiplication symbol.

36. The base station according to any one of claims 32 to 35, wherein the configuration unit is further configured to configure the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal.

37. A terminal, characterized by comprising a receiving unit, a selection unit, and a feedback unit, wherein

the receiving unit is configured to receive and detect pilot signals of N pilot ports configured by a base station;

the selection unit is configured to select K pilot ports from the N pilot ports based on received signal quality; and

the feedback unit is configured to feed back channel information of a channel formed by the K pilot ports and the terminal, wherein K is a positive integer less than N.

38. The terminal according to claim 37, wherein the channel information comprises at least one of the following: index information of the K pilot ports, amplitude ratio information between the K pilot ports, phase difference information between the K pilot ports, received power information of the K pilot ports, or signal-to-interference-plus-noise ratio information of the K pilot ports.

39. The terminal according to claim 37, wherein the selection unit is further configured to select the K pilot ports from the N pilot ports based on a power threshold configured by the base station, wherein

the power threshold is a relative threshold or an absolute threshold.

40. The terminal according to claim 37, wherein the feedback unit is further configured to feed back pilot port selection information, wherein the pilot port selection information is jointly coded by using a quantity of selected pilot ports and an identifier of the selected pilot port, different pilot ports have different probabilities of being selected, and different quantities of pilot ports correspond to different status bits.

41. The terminal according to any one of claims 37 to 40, wherein the terminal further comprises a virtualization unit, configured to form the K pilot ports through virtualization of a same set of antennas, wherein each of the K pilot ports corresponds to a set of virtualized precoding weights.

42. A beam transmission system, characterized by comprising a base station and a terminal, wherein the base station is configured to: pre-select P beam weights, and process the P beam weights based on a channel correlation matrix fed back by the terminal, to obtain P new beams; and send the P new beams to the terminal; and

the terminal is configured to select Q beams from the P new beams, and feed back the Q beams to the base station.

43. The beam transmission system according to claim 42, wherein the channel correlation matrix is obtained by superposing and combining correlation matrix information of a plurality of terminals.

44. The beam transmission system according to claim 42 or 43, wherein the P beam weights are P DFT vectors or a function of two DFT vectors.

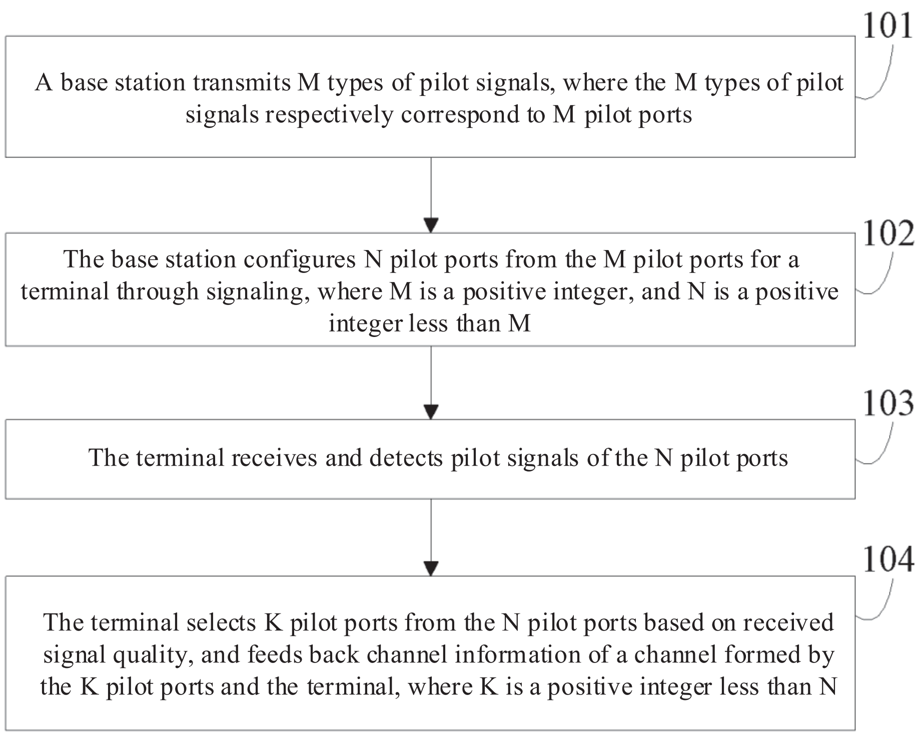

101
A base station transmits M types of pilot signals, where the M types of pilot signals respectively correspond to M pilot ports
102
The base station configures N pilot ports from the M pilot ports for a terminal through signaling, where M is a positive integer, and N is a positive integer less than M
103
The terminal receives and detects pilot signals of the N pilot ports
104
The terminal selects K pilot ports from the N pilot ports based on received signal quality, and feeds back channel information of a channel formed by the K pilot ports and the terminal, where K is a positive integer less than N

FIG. 1

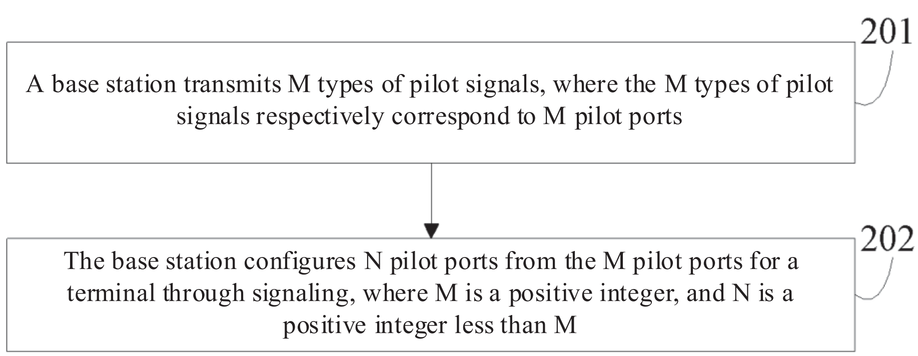

201
A base station transmits M types of pilot signals, where the M types of pilot signals respectively correspond to M pilot ports
202
The base station configures N pilot ports from the M pilot ports for a terminal through signaling, where M is a positive integer, and N is a positive integer less than M

FIG. 2

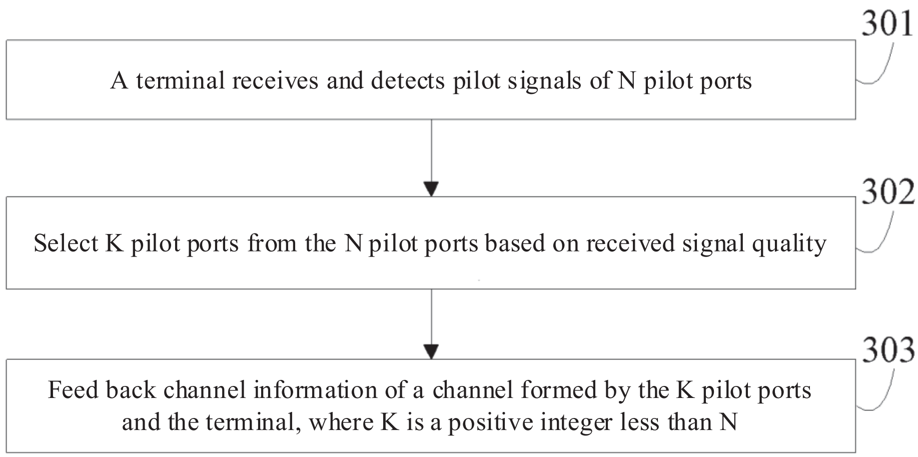


FIG. 3

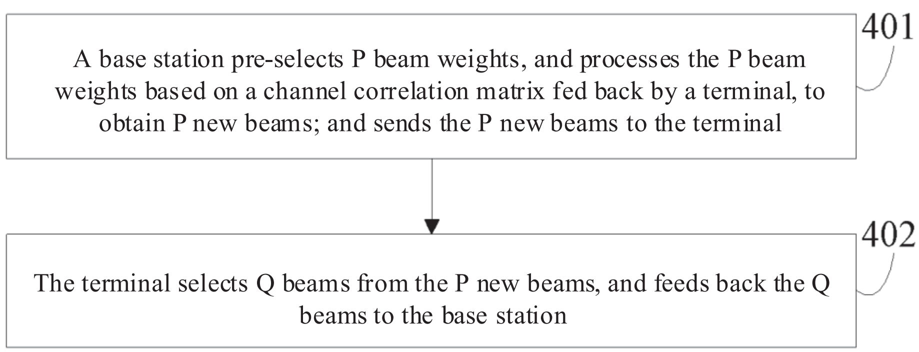


FIG. 4

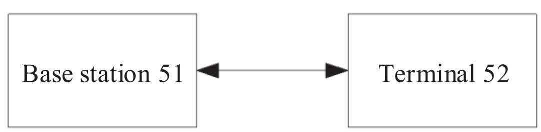


FIG. 5

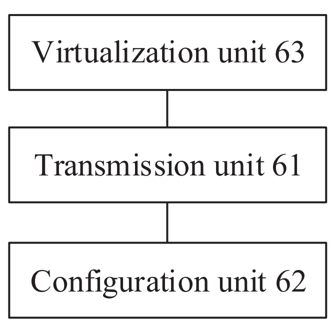


FIG. 6

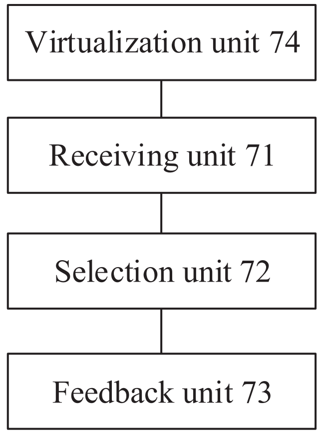

Virtualization unit 74
Receiving unit 71
Selection unit 72
Feedback unit 73

FIG. 7

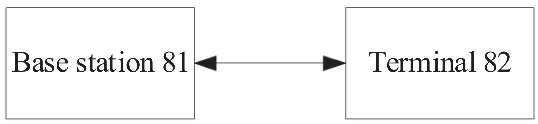

Base station 81
Terminal 82

FIG. 8

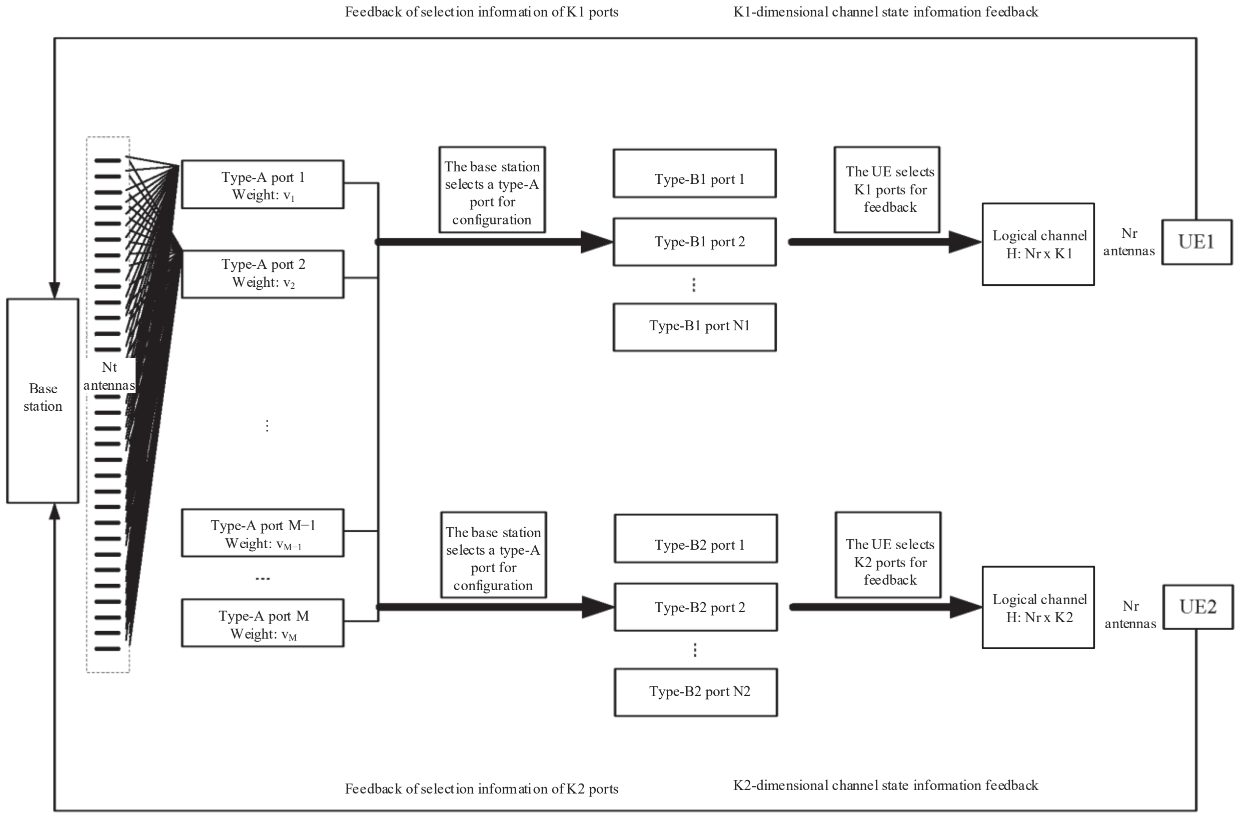

Feedback of selection information of K1 ports
K1-dimensional channel state information feedback
Base station
Nt antennas
Type-A port 1 Weight: v_1
Type-A port 2 Weight: v_2
Type-A port M−1 Weight: v_{M-1}
Type-A port M Weight: v_M
The base station selects a type-A port for configuration
Type-B1 port 1
Type-B1 port 2
Type-B1 port N1
The UE selects K1 ports for feedback
Logical channel H: Nr x K1
Nr antennas
UE1
The base station selects a type-A port for configuration
Type-B2 port 1
Type-B2 port 2
Type-B2 port N2
The UE selects K2 ports for feedback
Logical channel H: Nr x K2
Nr antennas
UE2
Feedback of selection information of K2 ports
K2-dimensional channel state information feedback

FIG. 9

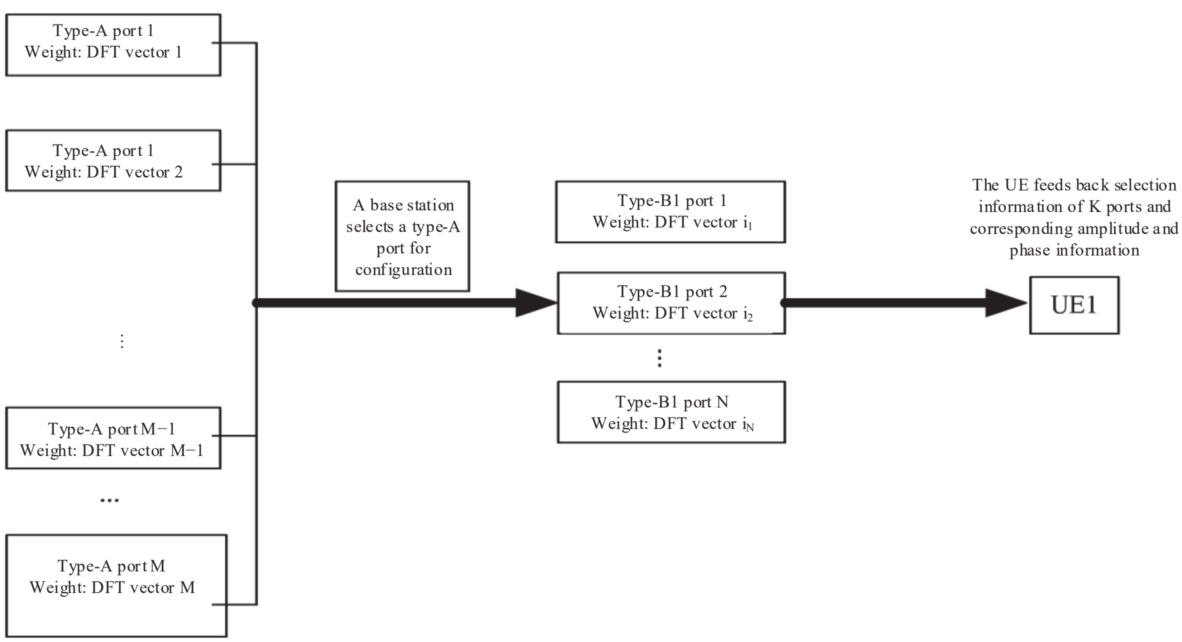

Type-A port 1 Weight: DFT vector 1
Type-A port 1 Weight: DFT vector 2
Type-A port M−1 Weight: DFT vector M−1
Type-A port M Weight: DFT vector M
A base station selects a type-A port for configuration
Type-B1 port 1 Weight: DFT vector i_1
Type-B1 port 2 Weight: DFT vector i_2
Type-B1 port N Weight: DFT vector i_N
The UE feeds back selection information of K ports and corresponding amplitude and phase information
UE1

FIG. 10

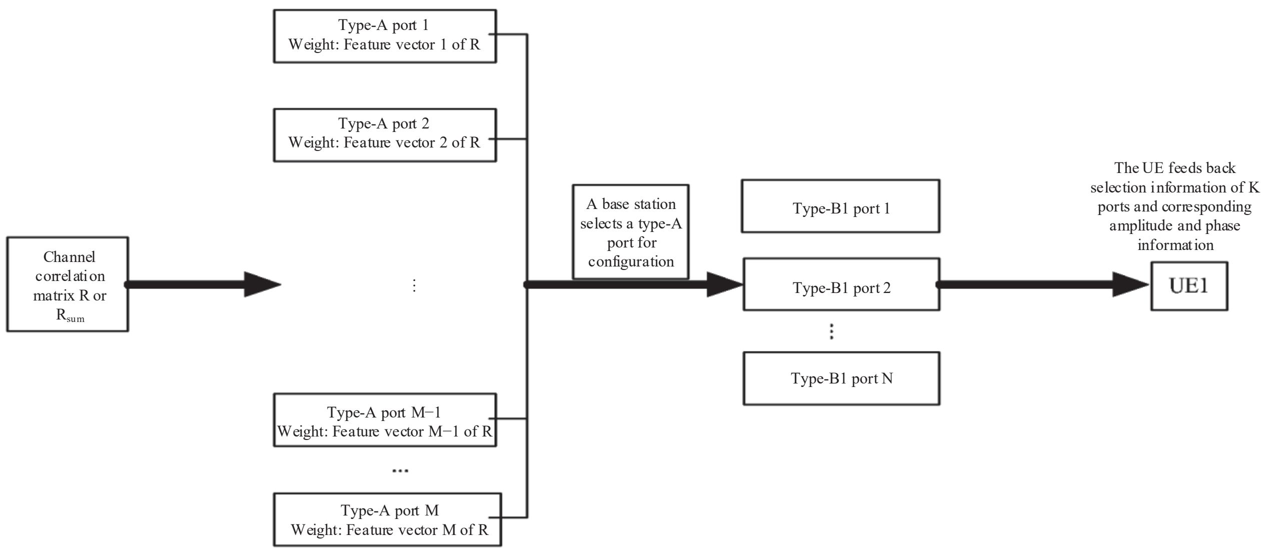

Type-A port 1
Weight: Feature vector 1 of R
Type-A port 2
Weight: Feature vector 2 of R
Channel correlation matrix R or R_{sum}
A base station selects a type-A port for configuration
Type-B1 port 1
Type-B1 port 2
Type-B1 port N
The UE feeds back selection information of K ports and corresponding amplitude and phase information
UE1
Type-A port M−1
Weight: Feature vector M−1 of R
Type-A port M
Weight: Feature vector M of R

FIG. 11

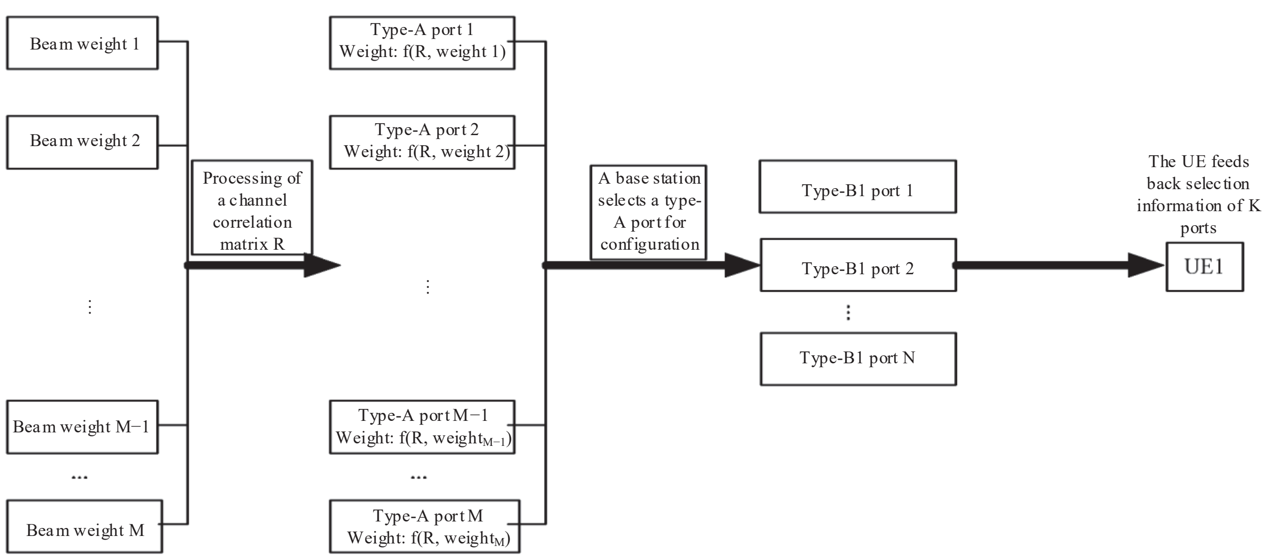

Beam weight 1
Beam weight 2
Beam weight M−1
Beam weight M
Processing of a channel correlation matrix R
Type-A port 1
Weight: f(R, weight 1)
Type-A port 2
Weight: f(R, weight 2)
Type-A port M−1
Weight: f(R, $weight_{M-1}$)
Type-A port M
Weight: f(R, $weight_M$)
A base station selects a type-A port for configuration
Type-B1 port 1
Type-B1 port 2
Type-B1 port N
The UE feeds back selection information of K ports
UE1

FIG. 12