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

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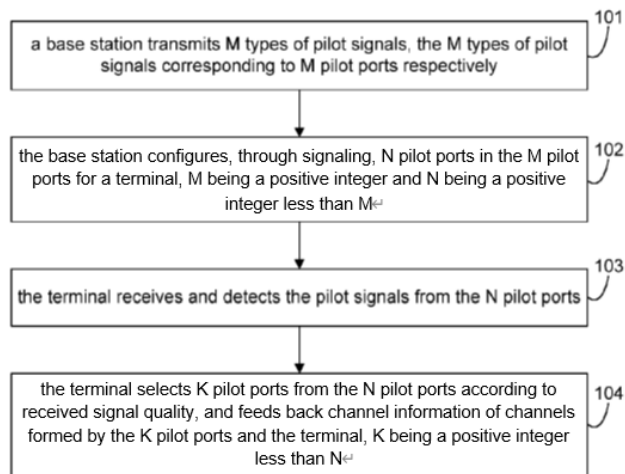


FIG. 1 / FIG. 1^a

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.

(57) Abstract: The present invention discloses a channel information feedback method, and pilot and beam transmission methods, systems, and devices. The channel information feedback method comprises: a base station transmits M types of pilot signals, the M types of pilot signals corresponding to M pilot ports respectively; and the base station configures, through signaling, N pilot ports in the M pilot ports for a terminal, M being a positive integer and N being a positive integer less than M; and the terminal receives and detects pilot signals from the N pilot ports, selects K pilot ports from the N pilot ports according to received signal quality, and feeds back channel information of channels formed by the K pilot ports and the terminal, K being a positive integer less than N.

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CHANNEL INFORMATION FEEDBACK METHOD, AND PILOT AND BEAM TRANSMISSION METHOD, SYSTEM, AND DEVICE

TECHNICAL FIELD

The present invention relates to a channel information feedback technology in communications, and in particular to a channel information feedback method and pilot and beam transmission methods, systems, and devices.

BACKGROUND

In a wireless communication system, a transmitter and a receiver achieve a higher data transmission rate by means of a plurality of antennas in a spatial multiplexing manner. Compared with a common spatial multiplexing manner, an enhanced spatial multiplexing manner refers to feeding back channel information to a transmitter by a receiver and performing data transmission according to the obtained channel information by adopting a transmission precoding technology by the transmitter, thereby greatly improving transmission performance. For single-user multi-input multi-output (MIMO), channel characteristic vector information is directly used for precoding; and for multi-user MIMO (MU-MIMO), more accurate channel information is required.

In some technologies consistent with 4th-Generation (4G) of mobile phone mobile communications standards, such as the Long Term Evolution (LTE) 802.16m standard specification, feedback of channel information mainly uses a simpler single-codebook feedback method, and performance of a transmission precoding technology for MIMO depends more on codebook feedback accuracy. A basic principle of codebook-based channel information quantized feedback is as follows:

If limited feedback channel capacity is B bps/Hz, the number N of available code words is 2^B . A characteristic vector space of a channel matrix is quantized to form a codebook space $\mathfrak{R} = \{F_1, F_2 \dots F_N\}$. The transmitter and the receiver both store or in real time generate the codebook. The receiver adopts the obtained channel matrix H , selects a code word $\hat{F}$ most matched with a channel from $\mathfrak{R}$ according to a certain criterion, and feeds back a sequence number i of the code word to the transmitter. Here, the sequence number of the code word refers to a Precoding Matrix Indicator (PMI). The transmitter queries the corresponding precoding code word $\hat{F}$ to obtain channel information according to the sequence number i . Here, $\hat{F}$ represents characteristic vector information of the channel.

Along with rapid development of wireless communication technology, wireless applications at user ends become increasingly rich, which promotes rapid increase of wireless data services but also brings great challenges to a radio access network. Multi-antenna technology is a key technology for dealing with the challenge of explosive increase of wireless data services. At present, multi-antenna technology supported by 4G only supports horizontal-dimension beamforming technology with a maximum of 8 ports. The multi-antenna technology is evolved mainly to achieve the following objectives: (1) a higher beamforming/precoding gain; (2) a larger spatial multiplexing layer number and lower interlayer interference; (3) more comprehensive coverage; and (4) lower inter-station interference. Massive MIMO is the most important technology for MIMO evolution in next-generation wireless communications.

For massive MIMO technology, a base station side is configured with a massive antenna array, for example, 100 antennas and even more. During data transmission, MU-MIMO technology is utilized to simultaneously multiplex multiple users at the same frequency. Generally, the number of antennas is about 5 to 10 times the number of multiplexed users. For strongly correlated channels in a line-of-sight environment and uncorrelated channels under rich scattering, the correlation coefficient between channels of any two users attenuates exponentially as the number of antennas increases. For example, when the base station side is configured with 100 antennas, the correlation coefficient between channels of any two users approaches 0, that is, channels corresponding to multiple users are approximately orthogonal. In another aspect, a massive array may bring a considerable array gain and diversity gain.

For massive MIMO technology, with the introduction of a large number of antennas, each antenna is required to transmit a Channel State Information-Reference Symbol (CSI-RS). And, a terminal detects the CSI-RSs, performs channel estimation to obtain a channel matrix corresponding to each transmission resource, obtains an optimal precoding vector of each frequency domain sub-band on a baseband and optimal broadband transmission layer number information according to the channel matrices, and then performs feedback on the basis of codebook feedback technology. Such a manner has many serious problems when being applied to massive MIMO. These problems are mostly manifested as follows: pilot overhead increases as the number of antennas increases; in addition, when a conventional codebook feedback technology is adopted for feedback, an adopted codebook is required to include many code words, making code word selection difficult, thus increasing the complexity of the terminal and making it difficult to implement; and the very high codebook feedback overhead results in high uplink overhead. It is difficult to achieve higher performance in a massive antenna system by means of the codebook feedback technology.

In summary, for a massive antenna system, efficiency and complexity of channel information feedback are important technical issues. At present, there is yet no effective method capable of improving efficiency of channel information feedback and reducing feedback complexity, and this has a serious impact on the industrial practicability of massive MIMO.

SUMMARY

In order to solve the aforementioned technical problems, embodiments of the present invention provide a channel information feedback method and pilot and beam transmission methods, systems, and devices.

A channel information feedback method provided by an embodiment of the present invention includes that:

a base station transmits M types of pilot signals, the M types of pilot signals corresponding to M pilot ports respectively; and the base station configures, through signaling, N pilot ports in the M pilot ports for a terminal, M being a positive integer and N being a positive integer less than M ; and

the terminal receives and detects pilot signals from the N pilot ports, selects K pilot ports from the N pilot ports according to received signal quality, and feeds back channel information of channels formed by the K pilot ports and the terminal, K being a positive integer less than N .

Preferably, the channel information includes at least one of: 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, and signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the method further includes that:

the K pilot ports are formed by virtualization of a same group of antennas, wherein each pilot port in the K pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further includes that:

the N pilot ports are formed by virtualization of a same group of antennas, wherein each pilot port in the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further includes that:

the base station determines the N pilot ports according to channel statistic information fed back by the terminal, wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

Preferably, the virtualized precoding weights corresponding to the N pilot ports are: DFT vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

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

Preferably, the method further includes that:

the terminal selects the K pilot ports from the N pilot ports according to a power threshold configured by the base station, wherein the power threshold is a relative threshold or an absolute threshold.

Preferably, the method further includes that:

the base station configures the N pilot ports in the M pilot ports for the terminal according to terminal information reported by the terminal.

Preferably, the method further includes that:

the terminal feeds back selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports, wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

A pilot transmission method provided by the embodiments of the present invention includes that:

a base station transmits M types of pilot signals, the M types of pilot signals corresponding to M pilot ports respectively; and the base station configures, through signaling, N pilot ports in the M pilot ports for a terminal, M being a positive integer and N being a positive integer less than M.

Preferably, the method further includes that:

the N pilot ports are formed by virtualization of a same group of antennas, wherein each pilot port in the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further includes that:

the base station determines the N pilot ports according to channel statistic information fed back by the terminal, wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

Preferably, the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

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

Preferably, the method further includes that:

the base station configures the N pilot ports in the M pilot ports for the terminal according to terminal information reported by the terminal.

A channel information feedback method provided by an embodiment of the present invention includes that:

a terminal receives and detects pilot signals from N pilot ports configured by a base station, selects K pilot ports from the N pilot ports according to received signal quality, and feeds back channel information of channels formed by the K pilot ports and the terminal, K being a positive integer less than N.

Preferably, the channel information includes at least one of: 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, and signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the method further includes that: the method further includes that:

the terminal selects the K pilot ports from the N pilot ports according to a power threshold configured by the base station, wherein the power threshold is a relative threshold or an absolute threshold.

Preferably, the method further includes that:

the terminal feeds back selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports, wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

Preferably, the method further includes that:

the K pilot ports are formed by virtualization of a same group of antennas, wherein each pilot port in the K pilot ports corresponds to a set of virtualized precoding weights.

A beam transmission method provided by an embodiment of the present invention includes that:

a base station preselects P beam weights, processes the P beam weights to obtain P new beams according to a channel correlation matrix fed back by a terminal, and transmits the P new beams to the terminal; and

the terminal selects Q beams from the P new beams, and feeds back the Q beams to the base station.

Preferably, the channel correlation matrix is a superposition and combination of correlation matrix information of a plurality of terminals.

Preferably, the P beam weights are: P DFT vectors or functions of two DFT vectors.

A channel information feedback system provided by an embodiment of the present invention includes: a base station and a terminal; wherein

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

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

Preferably, the channel information includes at least one of: 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, and signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the terminal is further configured to form the K pilot ports by virtualization of a same group of antennas, wherein each pilot port in 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 by virtualization of a same group of antennas, wherein each pilot port in 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 according to channel statistic information fed back by the terminal, wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

Preferably, the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

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

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

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

Preferably, the terminal is further configured to feed back selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports, wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

A base station provided by an embodiment of the present invention includes a transmission unit and a configuration unit, wherein

the transmission unit is configured to transmit M types of pilot signals, the M types of pilot signals corresponding to M pilot ports respectively; and

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

Preferably, the base station further includes a virtualization unit, configured to form the N pilot ports by virtualization of a same group of antennas, wherein each pilot port in 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 according to channel statistic information fed back by the terminal, wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

Preferably, the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

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

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

A terminal provided by an embodiment of the present invention includes a receiving unit, a selection unit, and a feedback unit, wherein

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

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

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

Preferably, the channel information includes at least one of: 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, and 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 according to a power threshold configured by the base station, wherein the power threshold is a relative threshold or an absolute threshold.

Preferably, the feedback unit is further configured to feed back selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports, wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

Preferably, the terminal further includes a virtualization unit, configured to form the K pilot ports by virtualization of a same group of antennas, wherein each pilot port in the K pilot ports corresponds to a set of virtualized precoding weights.

A beam transmission system provided by an embodiment of the present invention includes a base station and a terminal, wherein

the base station is configured to preselect P beam weights, processes the P beam weights to obtain P new beams according to a channel correlation matrix fed back by the terminal, and transmits the P new beams to the terminal; and

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

Preferably, the channel correlation matrix is a superposition and combination of correlation matrix information of a plurality of terminals.

Preferably, the P beam weights are: P DFT vectors or functions of two DFT vectors.

According to the technical solutions of embodiments of the present invention, the base station transmits the M types of pilot signals, the M types of pilot signals corresponding to the M pilot ports respectively; and the base station configures, through signaling, the N pilot ports in the M pilot ports for the terminal, M being a positive integer and N being a positive integer less than M . Therefore, the dimension of channel information of the M pilot ports is reduced to the dimension of channel information of the N pilot ports, thus enabling the terminal to select the K pilot ports from the N pilot ports to feed back the channel information in a subspace determined on the basis of correlation. Moreover, the terminal selects the K pilot ports from the N pilot ports to feed back the channel information, so that the dimension of the channel information may further be reduced, and channel information feedback overhead is greatly reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

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

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

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

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

FIG. 5 is a structural diagram illustrating a channel information feedback system according to embodiment 1 of the present invention;

FIG. 6 is a structural diagram illustrating a base station according to embodiment 2 of the present invention;

FIG. 7 is a structural diagram illustrating a terminal according to embodiment 3 of the present invention;

FIG. 8 is a structural diagram illustrating a beam transmission system according to embodiment 4 of the present invention;

FIG. 9 is a diagram illustrating precoding by a base station according to an embodiment of the present invention;

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

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

FIG. 12 is a diagram illustrating beam-weight based channel information feedback according to an embodiment of the present invention.

DETAILED DESCRIPTION

In order to facilitate a more thorough understanding of characteristics and technical contents of embodiments of the present invention, implementation of the embodiments of the present invention will be elaborated below in detail with reference to the drawings, and the appended drawings are only intended for

description as references and not intended to limit the embodiments of the present invention.

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

Step 101: a base station transmits M types of pilot signals, the M types of pilot signals corresponding to M pilot ports respectively.

Here, M is an integer greater than 1; for example, M is 64.

Specifically, referring to FIG. 9, the base station has N_t transmission antennas which are the same, wherein N_t is an integer greater than 1. Each transmission antenna transmits a path of signal, and the N_t transmission antennas transmit N_t paths of signals. In the embodiment, the N_t paths of signals transmitted by the N_t transmission antennas are virtualized to obtain the M types of pilot signals. Here, virtualization specifically refers to precoding; that is, the N_t paths of signals are multiplied by N_t corresponding weights respectively to obtain a type of pilot signals. As such, the N_t weights form a set of weight vectors with a dimension of N_t , and each type of pilot signals correspond 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 the pilot signals precoded by the weight vectors are directional because the weight vectors are directional.

Step 102: the base station configures, through signaling, N pilot ports in the M pilot ports for a terminal, M being a positive integer and N being a positive integer less than M .

Preferably, the method further includes that:

the base station configures the N pilot ports in the M pilot ports for the terminal according to terminal information reported by the terminal.

Preferably, the method further includes that:

the N pilot ports are formed by virtualization of a same group of antennas, wherein each pilot port in the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further includes that:

the base station determines the N pilot ports according to channel statistic information fed back by the terminal, wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

Preferably, the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

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

Specifically, referring to FIG. 10, preset beam weights may be DFT vectors, and the M types of pilot signals, i.e. M DFT vectors corresponding to the M pilot ports, are shown in formula (1):

$$\begin{aligned} v_1 &= [1 \quad e^{j\phi_1} \quad \dots \quad e^{j(P_1-1)\phi_1}]^H \\ v_2 &= [1 \quad e^{j\phi_2} \quad \dots \quad e^{j(P_2-1)\phi_2}]^H \\ &\dots \\ v_M &= [1 \quad e^{j\phi_M} \quad \dots \quad e^{j(P_M-1)\phi_M}]^H \end{aligned} \tag{1}$$

where $v_1, v_2, \dots, v_M$ represent M DFT vectors; $P_1, P_2, \dots, P_M$ are all equal to N_t ; $\phi_1, \phi_2, \dots, \phi_M$ are uniformly quantized phase parameters from 0 to 2π ; and $[]^H$ represents conjugate transpose.

The aforementioned DFT vectors utilize a multipath principle, that is, the DFT vectors correspond to optimal beam weights of paths. Since a channel is synthesized by multiple paths, for the M types of pilot signals, some pilot ports receive stronger pilot signals, meaning that multipath components are stronger; and some pilot ports receive weaker pilot signals, meaning that multipath components are weaker.

In the aforementioned solution, the N_t transmission antennas form a linear array. When the N_t transmission antennas form an antenna array of another form, such as a two-dimensional antennas array, the beam weights corresponding to the M types of pilot signals are in a form of functions of two DFT vectors, as shown in formula (2):

$$f(v_i, v_j) = v_i \otimes v_j \quad (2)$$

where v_i and v_j are shown in formula (1), and the product of P_i corresponding to v_i and P_j corresponding to v_j is equal to the number N_t of the transmission antennas.

The beam weights corresponding to the M types of pilot signals of the two-dimensional antenna array may also be obtained by formula (3):

$$f(v_k, v_l) = \begin{bmatrix} v_k \\ v_l \end{bmatrix} \quad (3)$$

where v_i and v_j are shown in formula (1), and the product of P_i corresponding to v_i and P_j corresponding to v_j is equal to half of the number of the transmission antennas, i.e. $N_t/2$.

Here, not every terminal is required to detect the M pilot ports corresponding to the M types of pilot signals, and the base station may configure some ports for each terminal to detect. For example, for User Equipment 1 (UE1), $N_1=16$ pilot ports may be configured for detection, and for UE2, $N_2=8$ pilot ports may be configured for detection. Specific pilot ports may be determined by the base station according to position information of the terminal or some rough channel information reported by the terminal.

Step 103: the terminal receives and detects pilot signals from the N pilot ports.

Specifically, the base station transmits port information of the N pilot ports to the terminal. Further, the terminal detects, according to the port information, the N types of pilot signals from the N pilot ports to obtain received powers corresponding to the N types of pilot signals. The terminal selects K pilot ports from the N pilot ports on the basis of the received powers corresponding to the N types of pilot signals. The terminal transmits channel information of the K pilot ports to the base station.

Specifically, the terminal receives the port information of the N pilot ports transmitted from the base station. Here, the base station selects, according to the position information of the terminal or the channel information, the N pilot ports from the M generated pilot ports, wherein $N < M$.

Step 104: the terminal selects K pilot ports from the N pilot ports according to received signal quality, and feeds back channel information of channels formed by the K pilot ports and the terminal, K being a positive integer less than N.

Preferably, the method further includes that:

the terminal selects the K pilot ports from the N pilot ports according to a power threshold configured by the base station, wherein the power threshold is a relative threshold or an absolute threshold.

After acquiring the port information transmitted by the base station, the terminal detects the pilot signals at corresponding port positions to obtain the received powers corresponding to the N types of pilot signals. Specifically, when N is 8,

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

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

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

...

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

Preferably, the channel information includes at least one of: 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, and signal-to-interference-plus-noise ratio information of the K pilot ports.

Specifically, the received powers corresponding to the N types of pilot signals are compared with a preset threshold value respectively;

when a received power is greater than or equal to the threshold value, it is determined that the pilot port corresponding to the received power is a port of a first type;

when a received power is less than the threshold value, it is determined that the pilot port corresponding to the received power is a port of a second type; and

the ports of the first type are selected from the N pilot ports, the number of the ports of the first type being K.

Alternatively, a maximum received power in the received powers corresponding to the N types of pilot signals is determined;

the received powers corresponding to the N types of pilot signals are compared with the maximum received power respectively;

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

when the ratio of a received power to the maximum received power is less than the preset threshold value, it is determined that the pilot port corresponding to the received power is a port of a second type; and

the ports of the first type are selected from the N pilot ports, the number of the ports of the first type being K .

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

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

Preferably, the method further includes that:

the K pilot ports are formed by virtualization of a same group of antennas, wherein each pilot port in the K pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further includes that:

the terminal feeds back selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports, wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

In this embodiment, after the K pilot ports are selected from the N pilot ports, selection information of the K pilot ports is also reported. Specifically, the probability of being selected is different for each pilot port. For some of the pilot ports, the selection probability is high, while for some other pilot ports, the selection probability is low. As such, the probabilities associated with the pilot ports may be represented by coding. For example, if $K=2$ pilot ports are selected from $N=8$ pilot ports, coding information is shown in Table 1.

0000	Port1,Port2	1000	Port2,Port4
0001	Port1,Port3	1001	Port2,Port5
0010	Port1,Port4	1010	Port2,Port6
0011	Port1,Port5	1011	Port2,Port7
0100	Port1,Port6	1100	Port2,Port8
0101	Port1,Port7	1101	Port3,Port4
0110	Port1,Port8	1110	Port3,Port5
0111	Port2,Port3	1111	Port4,Port5

TABLE 1

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

0000	Port1,Port2,Port3	1000	Port1,Port3,Port6
0001	Port1,Port2,Port4	1001	Port1,Port3,Port7
0010	Port1,Port2,Port5	1010	Port1,Port3,Port8
0011	Port1,Port2,Port6	1011	Port2,Port3,Port4
0100	Port1,Port2,Port7	1100	Port2,Port3,Port5
0101	Port1,Port2,Port8	1101	Port2,Port3,Port6
0110	Port1,Port3,Port4	1110	Port2,Port3,Port7
0111	Port1,Port3,Port5	1111	Port2,Port3,Port8

TABLE 2

In addition, the probability that a certain number of pilot ports are selected also differs. For example, the probability that the number of selected pilot ports is 2 is different from the probability that the number of selected pilot ports is 4. Thus, joint coding with respect to the number of pilot ports and selection probability of the pilot ports may alternatively be implemented to reduce coding overhead; the coding information is shown in Table 3.

0000	Port1,Port2	1000	Port2,Port4
0001	Port1,Port3	1001	Port3,Port4
0010	Port1,Port4	1010	Port3,Port5
0011	Port1,Port5	1011	Port4,Port5
0100	Port1,Port6	1100	Port1,Port2,Port3
0101	Port1,Port7	1101	Port1,Port2,Port4
0110	Port1,Port8	1110	Port1,Port3,Port4
0111	Port2,Port3	1111	Port2,Port3,Port4

TABLE 3

The phase difference information is information about phase difference calculated after beam signals received by receiving antennas are averaged.

Specifically, for the selected pilot ports, the terminal feeds back amplitude/power information and phase information of the pilot ports. Herein, it is preferable that relative information between the pilot ports is fed back, such as an amplitude/power ratio and the phase difference information. The following manner may be adopted for the amplitude/power ratio: a pilot port with the highest power is indicated, and a ratio of an amplitude or power of a pilot port to that of the pilot port with the highest power is fed back. Specifically, as shown in Table 4, a magnitude order of the amplitude or power is indicated first, and then a coefficient at the magnitude order is indicated. The coefficient may be uniformly quantized. The phase difference information may be uniformly quantized from 0 to 2π and fed back.

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

TABLE 4

Here, when the beam weights are DFT vectors, the received power information and the phase difference information are specifically amplitude and phase difference information of the multiple paths. The base station may reconstruct, on the basis of the received channel information, the beam weights for precoding optimization.

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

Step 201: a base station transmits M types of pilot signals, the M types of pilot signals corresponding to M pilot ports respectively; and

Step 202: the base station configures, through signaling, N pilot ports in the M pilot ports for a terminal, M being a positive integer and N being a positive integer less than M.

Preferably, the method further includes that:

the N pilot ports are formed by virtualization of a same group of antennas, wherein each pilot port in the N pilot ports corresponds to a set of virtualized precoding weights.

Preferably, the method further includes that:

the base station determines the N pilot ports according to channel statistic information fed back by the terminal, wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

Preferably, the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

where k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, and ϕ_k

is a phase parameter; and $[\]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct product symbol.

Preferably, the method further includes that:

the base station configures the N pilot ports in the M pilot ports for the terminal according to terminal information reported by the terminal.

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

Step 301: a terminal receives and detects pilot signals from N pilot ports configured by a base station.

Step 302: K pilot ports are selected from the N pilot ports according to received signal quality.

Preferably, the method further includes that: the method further includes that:

the terminal selects the K pilot ports from the N pilot ports according to a power threshold configured by the base station, wherein the power threshold is a relative threshold or an absolute threshold.

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

Preferably, the channel information includes at least one of: 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, and signal-to-interference-plus-noise ratio information of the K pilot ports.

Preferably, the method further includes that:

the terminal feeds back selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports, wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

Preferably, the method further includes that:

the K pilot ports are formed by virtualization of a same group of antennas, wherein each pilot port in the K pilot ports corresponds to a set of virtualized precoding weights.

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

Step 401: a base station preselects P beam weights, processes the P beam weights to obtain P new beams according to a channel correlation matrix fed back by a terminal, and transmits the P new beams to the terminal.

Preferably, the channel correlation matrix is a superposition and combination of correlation matrix information of a plurality of terminals.

Specifically, more than one received channel correlation sub-matrix is superposed to obtain the channel correlation matrix; and

signals corresponding to a plurality of transmission antennas are precoded, according to characteristic vectors of the channel correlation matrix, to obtain M types of pilot signals.

Specifically, referring to FIG. 11, the preset beam weights may also be a channel correlation matrix **R**. The base station receives channel correlation sub-matrices fed back by more than one UE and superposes the more than one channel correlation sub-matrix to obtain a channel correlation matrix **R**. Here, the channel correlation sub-matrices are channel correlation matrix information of the terminal, such as information of each element of the channel correlation matrix **R**, characteristic value information of the channel correlation matrix **R**, and characteristic vector information of the channel correlation matrix **R**.

When the beam weights are channel correlation matrices **R**, the base station superposes, on the basis of received channel information transmitted by more than one terminal, the correlation matrices **R** to reconstruct the beam weights for precoding optimization.

Specifically, referring to FIG. 12, the base station preselects the P beam weights, and the P beam weights may be some relatively uniform weights, that is, chordal distances are required to be greater than a threshold, such as 0.9. The P selected beam weights may be some DFT vectors or some uniform vectors in an N_t -dimensional space generated by the Grassmanian method.

The terminal feeds back its corresponding channel correlation sub-matrix, and this channel correlation sub-matrix is measured and obtained by the terminal. The base station may take a channel correlation sub-matrix of one terminal or a superposed value $\mathbf{R}$ of channel correlation sub-matrices of a plurality of terminals as a beam weight rotation matrix, multiply the beam weight rotation matrix by the P selected beam weights, and then perform normalization power processing.

After rotation, the P uniform beams may undergo distribution adjustment according to correlation in $\mathbf{R}$, so that beams in some subspaces are denser and beams in some other subspaces are sparser. More characteristic vectors of the terminal are positioned in the subspaces where the beams are denser.

The terminal selects information corresponding to one or more optimal pilot ports from the received pilot signals and reports the information to the base station. The base station may find the corresponding pilot ports and the corresponding beam weights according to the port information reported by the terminal and use the beam weights to perform precoding.

Preferably, the P beam weights are: P DFT vectors or functions of two DFT vectors.

Step 402: the terminal selects Q beams from the P new beams, and feeds back the Q beams to the base station.

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

the base station 51 is configured to transmit M types of pilot signals, the M types of pilot signals corresponding to M pilot ports respectively, and to configure, through signaling, N pilot ports in the M pilot ports for the terminal 52, M being a positive integer and N being a positive integer less than M ; and

the terminal 52 is configured to receive and detect pilot signals from the N pilot ports, to select K pilot ports from the N pilot ports according to received signal quality, and to feed back channel information of channels formed by the K pilot ports and the terminal 52, K being a positive integer less than N .

Preferably, the channel information includes at least one of: 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, and 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 by virtualization of a same group of antennas, wherein each pilot port in 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 by virtualization of a same group of antennas, wherein each pilot port in 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 according to channel statistic information fed back by the terminal 52, wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

Preferably, the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

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

Preferably, the terminal 52 is further configured to select the K pilot ports from the N pilot ports according to a power threshold configured by the base station 51, wherein 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 in the M pilot ports for the terminal 52 according to terminal 52 information reported by the terminal 52.

Preferably, the terminal 52 is further configured to feed back selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports, wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

Those skilled in the art should know that functionalities implemented by the base station 51 and the terminal 52 in the channel information feedback system shown in FIG. 5 may be understood with reference to related descriptions made in the abovementioned channel information feedback method.

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

the transmission unit 61 is configured to transmit M types of pilot signals, the M types of pilot signals corresponding to M pilot ports respectively; and

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

Preferably, the base station further includes a virtualization unit 63, configured to form the N pilot ports by virtualization of a same group of antennas, wherein each pilot port in 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 according to channel statistic information fed back by the terminal, wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

Preferably, the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors, wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

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

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

Those skilled in the art should know that functionalities implemented by each unit in the base station shown in FIG. 6 may be understood with reference to related descriptions made in the abovementioned pilot transmission method.

In a practical 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), or a Digital Signal Processor (DPS), or a Field-Programmable Gate Array (FPGA) in the base station.

FIG. 7 is a structural diagram illustrating a terminal according to embodiment 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, wherein

the receiving unit 71 is configured to receive and detect pilot signals from N pilot ports configured by a base station;

the selection unit 72 is configured to select K pilot ports from the N pilot ports according to received signal quality; and

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

Preferably, the channel information includes at least one of: 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, and 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 according to a power threshold configured by the base station, wherein the power threshold is a relative threshold or an absolute threshold.

Preferably, the feedback unit 73 is further configured to feed back selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports, wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

Preferably, the terminal further includes a virtualization unit 74, configured to form the K pilot ports by virtualization of a same group of antennas, wherein each pilot port in the K pilot ports corresponds to a set of virtualized precoding weights.

Those skilled in the art should know that functionalities implemented by each unit in the terminal shown in FIG. 7 may be understood with reference to related descriptions made in the abovementioned channel information feedback method.

In a practical 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, or a DSP or a FPGA in the terminal.

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

the base station 81 is configured to preselect P beam weights, to process the P beam weights to obtain P new beams according to a channel correlation matrix fed back by the terminal 82, and to transmit the P new beams to the terminal 82; and

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

Preferably, the channel correlation matrix is a superposition and combination of correlation matrix information of a plurality of terminals 82.

Preferably, the P beam weights are: P DFT vectors or functions of two DFT vectors.

Those skilled in the art should know that functionalities implemented by the base station 81 and the terminal 82 in the beam transmission system shown in FIG. 8 may be understood with reference to related descriptions made in the abovementioned beam transmission method.

In some embodiments provided by the present invention, it should be understood that the disclosed equipment and methods may be implemented in other manners. The equipment embodiments described above are only illustrative. For example, the units are distinguished in a logic functionality way, and other ways may be adopted in practical implementation. For example, a plurality of units or components may be combined, or they may be integrated into another system, or some characteristics may be omitted or not executed. In addition, coupling or direct coupling or communication connection between the displayed or discussed components may be indirect coupling or communication connection through some interfaces; indirect coupling or communication connection between sets of equipment or units may be electrical connection, mechanical connection, or connection in another form.

The aforementioned units described as separate members may or may not be physically separated, and members displayed as units may or may not be physical units, that is, these units may be located in the same place, or may be arranged on a plurality of network units. Part or all of the units may be selected to implement the solution of the embodiment based on actual requirements.

In addition, all functionality units in the embodiments of the present invention may be integrated into a single processing unit, or each unit may exist independently, or two or more units may be integrated into one single unit. The aforementioned integrated unit may be implemented in a hardware form or in a form combining hardware and software functionality unit.

Those skilled in the art may know that all or part of the steps of the aforementioned method embodiments may be implemented by a program instructing related hardware; the foregoing program may be stored in a computer-readable storage medium; and, the program, when being executed, executes the steps of the aforementioned method embodiments. The foregoing storage medium includes various media capable of storing program codes, such as mobile storage equipment, a Read-Only Memory (ROM), a magnetic disk, or a compact disc.

Alternatively, the aforementioned integrated unit of the present invention, when being implemented in a form of software functionality unit and sold or used as an independent product, may be stored in a computer-readable storage medium. Based on this understanding, the technical solutions of the embodiments of the present invention may be substantially embodied in a form of software product, or those parts contributing to prior art may be embodied in a form of software product, and the computer software product is stored in a storage medium, including a number of instructions configured to enable computer equipment (which may be a personal computer, a server, network equipment, or the like) to execute all or part of the methods of the embodiments of the present invention. The foregoing storage medium includes various media capable of storing program codes, such as mobile storage equipment, a Read-Only Memory (ROM), a magnetic disk, or a compact disc.

The above is only specific implementation modes of the present invention and is not intended to limit the scope of protection of the present invention, and any variations or replacements apparent to those skilled in the art within the technical scope of the present invention shall fall within the scope of protection of the present invention. Therefore, the scope of protection of the present invention shall be in accordance with the scope of protection of the claims.

The above is only preferred embodiments of the present invention and is not intended to limit the

scope of protection of the present invention.

CLAIMS

1. A channel information feedback method, comprising:

transmitting, by a base station, M types of pilot signals, the M types of pilot signals corresponding to M pilot ports respectively; and configuring, by the base station through signaling, N pilot ports in the M pilot ports for a terminal, M being a positive integer and N being a positive integer less than M; and

receiving and detecting, by the terminal, pilot signals from the N pilot ports; and selecting K pilot ports from the N pilot ports according to received signal quality, and feeding back channel information of channels formed by the K pilot ports and the terminal, K being 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: 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, and signal-to-interference-plus-noise ratio information of the K pilot ports.

3. The channel information feedback method according to claim 1, further comprising:

forming the K pilot ports by virtualization of a same group of antennas; wherein each pilot port in the K pilot ports corresponds to a set of virtualized precoding weights.

4. The channel information feedback method according to claim 1, further comprising:

forming the N pilot ports by virtualization of a same group of antennas; wherein each pilot port in the N pilot ports corresponds to a set of virtualized precoding weights.

5. The channel information feedback method according to claim 4, further comprising:

determining, by the base station, the N pilot ports according to channel statistic information fed back by the terminal; wherein the channel statistic information is information of a correlation matrix, and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

6. The channel information feedback method according to claim 1, wherein the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors; wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

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

7. The channel information feedback method according to claim 1, further comprising:

selecting, by the terminal, the K pilot ports from the N pilot ports according to 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, further comprising:

configuring, by the base station, the N pilot ports in the M pilot ports for the terminal according to terminal information reported by the terminal.

9. The channel information feedback method according to any one of claims 1 through 8, further comprising:

feeding back, by the terminal, selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports; wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

10. A pilot transmission method, comprising:

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

11. The pilot transmission method according to claim 10, further comprising:

forming the N pilot ports by virtualization of a same group of antennas; wherein each pilot port in the N pilot ports corresponds to a set of virtualized precoding weights.

12. The pilot transmission method according to claim 10, further comprising:

determining, by the base station, the N pilot ports according to channel statistic information fed back by the terminal; wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

13. The pilot transmission method according to claim 10, wherein the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors; wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

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

14. The pilot transmission method according to any one of claims 10 through 13, further comprising:

configuring, by the base station, the N pilot ports in the M pilot ports for the terminal according to terminal information reported by the terminal.

15. A channel information feedback method, comprising:

receiving and detecting, by a terminal, pilot signals from N pilot ports configured by a base station; and selecting K pilot ports from the N pilot ports according to received signal quality, and feeding back channel information of channels formed by the K pilot ports and the terminal, K being 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: 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, and signal-to-interference-plus-noise ratio information of the K pilot ports.

17. The channel information feedback method according to claim 15, further comprising: further comprising:

selecting, by the terminal, the K pilot ports from the N pilot ports according to 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, further comprising:

feeding back, by the terminal, selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports; wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

19. The channel information feedback method according to any one of claims 15 through 18, further comprising:

forming the K pilot ports by virtualization of a same group of antennas; wherein each pilot port in the K pilot ports corresponds to a set of virtualized precoding weights.

20. A beam transmission method, comprising:

preselecting, by a base station, P beam weights, processing the P beam weights to obtain P new beams according to a channel correlation matrix fed back by a terminal, and transmitting 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 a superposition and combination of 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 functions of two DFT vectors.

23. A channel information feedback system, comprising: a base station and a terminal; wherein

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

the terminal is configured to receive and detect pilot signals from the N pilot ports, to select K pilot ports from the N pilot ports according to received signal quality, and to feed back channel information of channels formed by the K pilot ports and the terminal, K being 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: 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, and 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 by virtualization of a same group of antennas; wherein each pilot port in 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 by virtualization of a same group of antennas; wherein each pilot port in 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 according to channel statistic information fed back by the terminal; wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

28. The channel information feedback system according to claim 23, wherein the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors; wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

where k and l are positive integers, j is an imaginary unit, n is a positive integer greater than 1, and ϕ_k is a phase parameter; and $[\]^H$ represents a conjugate transpose operation, and $\otimes$ is a direct product 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 according to 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 in the M pilot ports for the terminal according to terminal information reported by the terminal.

31. The channel information feedback system according to any one of claims 23 through 30, wherein the terminal is further configured to feed back selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports; wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

32. A base station, comprising: a transmission unit and a configuration unit; wherein

the transmission unit is configured to transmit M types of pilot signals, the M types of pilot signals corresponding to M pilot ports respectively; and

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

33. The base station according to claim 32, further comprising: a virtualization unit, configured to form the N pilot ports by virtualization of a same group of antennas; wherein each pilot port in 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 according to channel statistic information fed back by the terminal; wherein the channel statistic information is information of a correlation matrix; and the virtualized precoding weights corresponding to the N pilot ports are characteristic vectors of the correlation matrix.

35. The base station according to claim 32, wherein the virtualized precoding weights corresponding to the N pilot ports are: Discrete Fourier Transform (DFT) vectors v_k , or Kronecker products $f(v_k, v_l)$ of the DFT vectors; wherein

$$v_k = [1 \quad e^{j\phi_k} \quad \dots \quad e^{j(n-1)\phi_k}]^H$$

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

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

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

37. A terminal, comprising: a receiving unit, a selection unit, and a feedback unit; wherein

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

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

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

38. The terminal according to claim 37, wherein the channel information comprises at least one of: 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, and 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 according to 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 selection information of the pilot ports, the selection information of the pilot ports being jointly coded with the number of the selected pilot ports and identifiers of the selected pilot ports, wherein selection probabilities of different pilot ports are different, and different numbers of the pilot ports correspond to different status bits.

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

42. A beam transmission system, comprising: a base station and a terminal; wherein

the base station is configured to preselect P beam weights, to process the P beam weights to obtain P new beams according to a channel correlation matrix fed back by the terminal, and to transmit the P new beams to the terminal; and

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

43. The beam transmission system according to claim 42, wherein the channel correlation matrix is a superposition and combination of 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 functions of two DFT vectors.

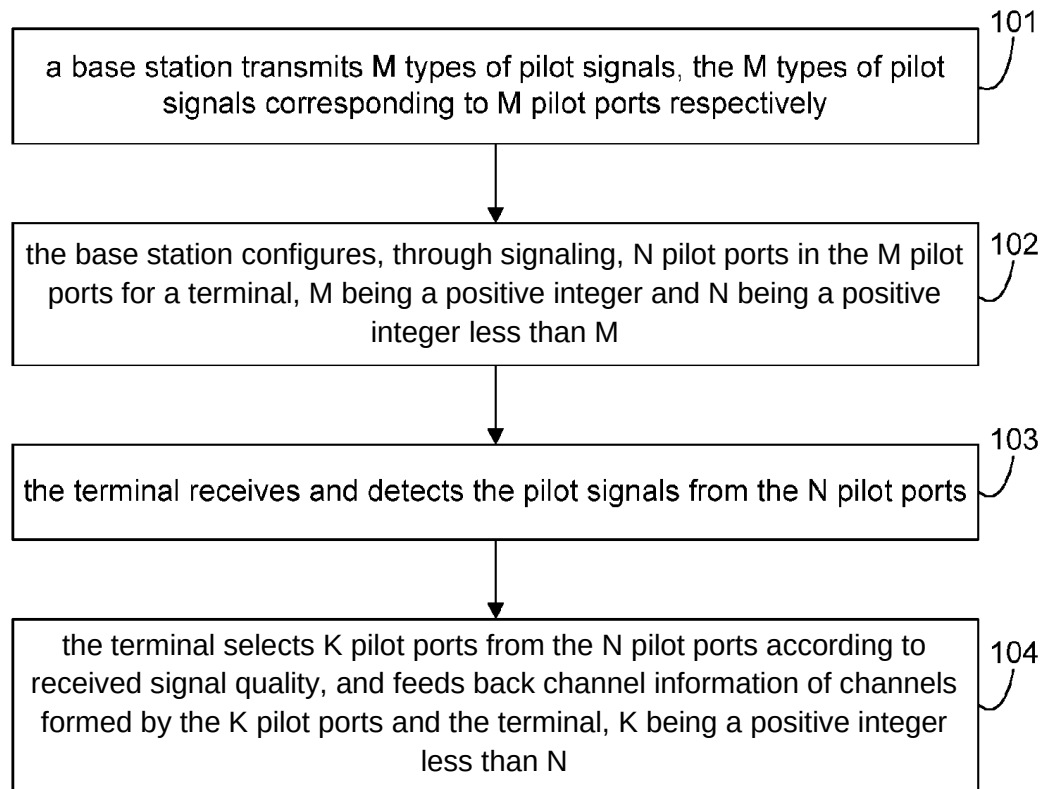


FIG. 1

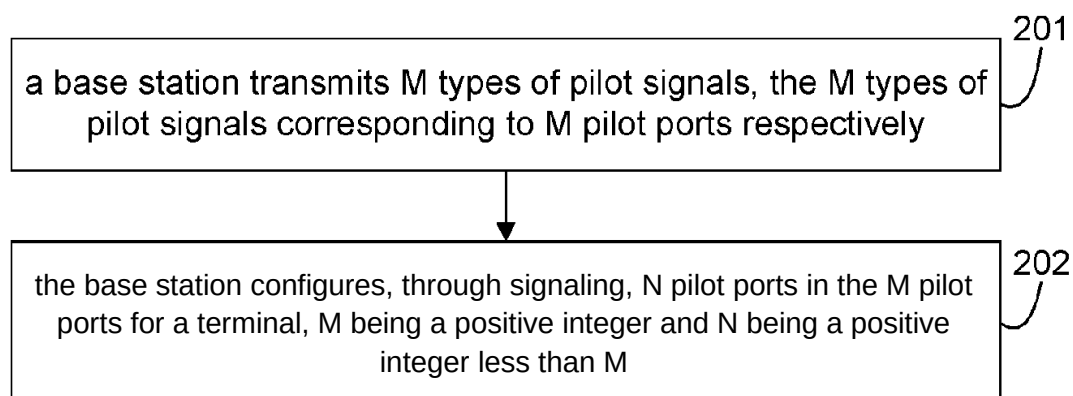


FIG. 2

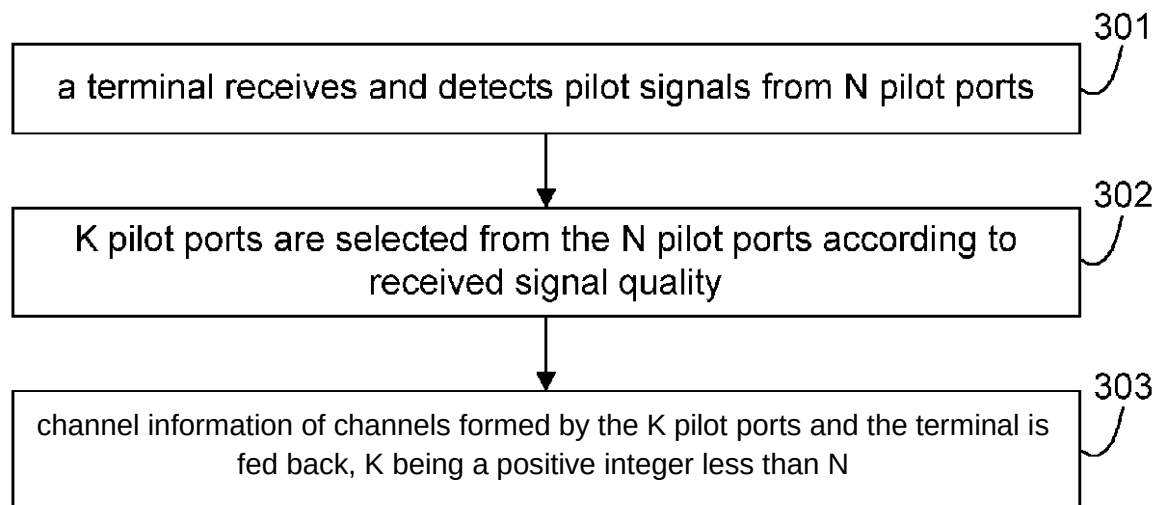


FIG. 3

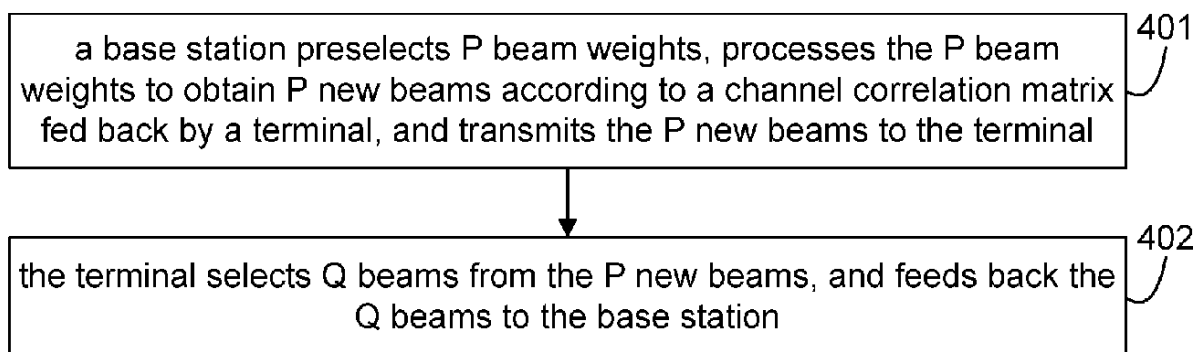


FIG. 4

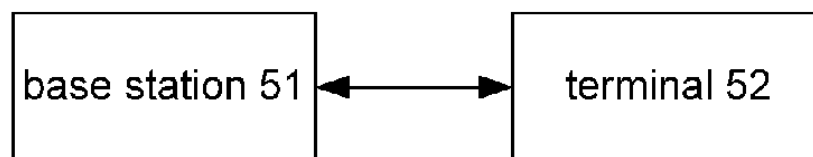


FIG. 5

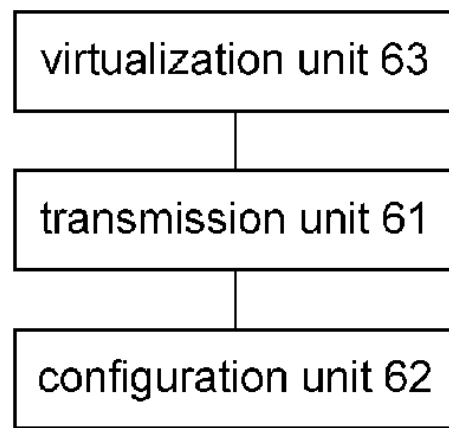


FIG. 6

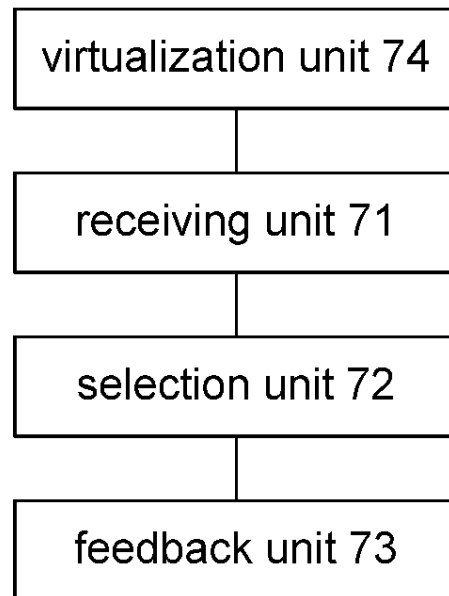


FIG. 7

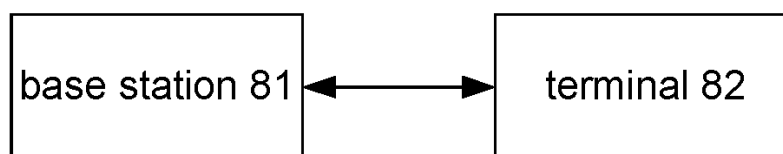


FIG. 8

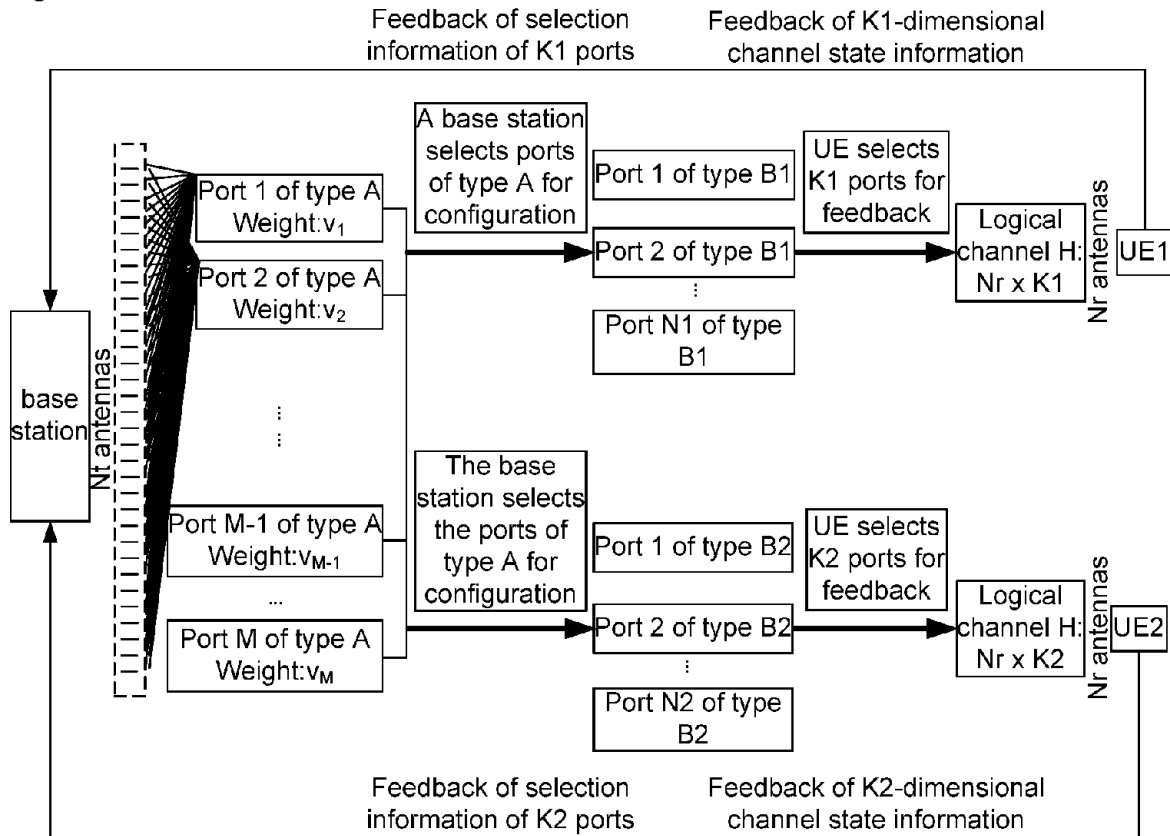


FIG. 9

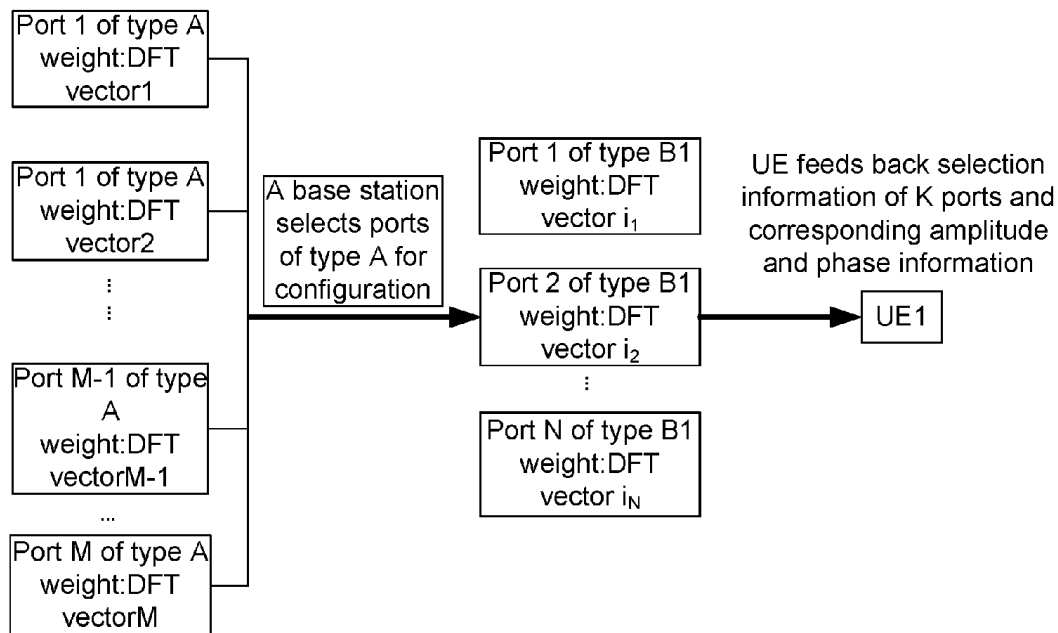


FIG. 10

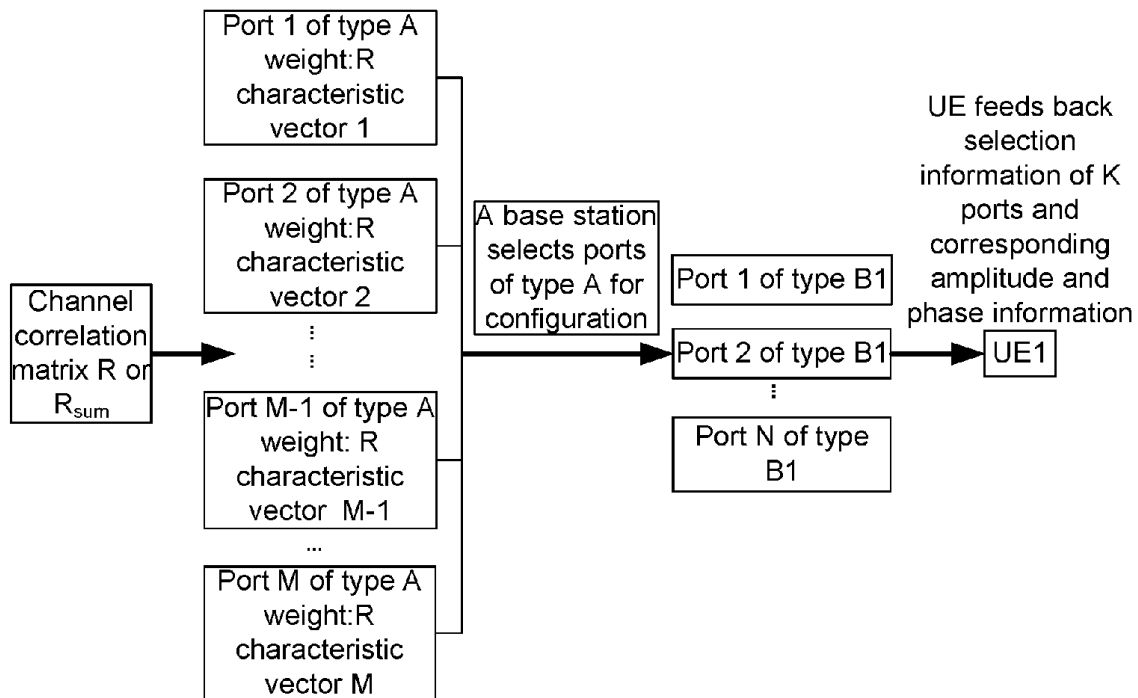


FIG. 11

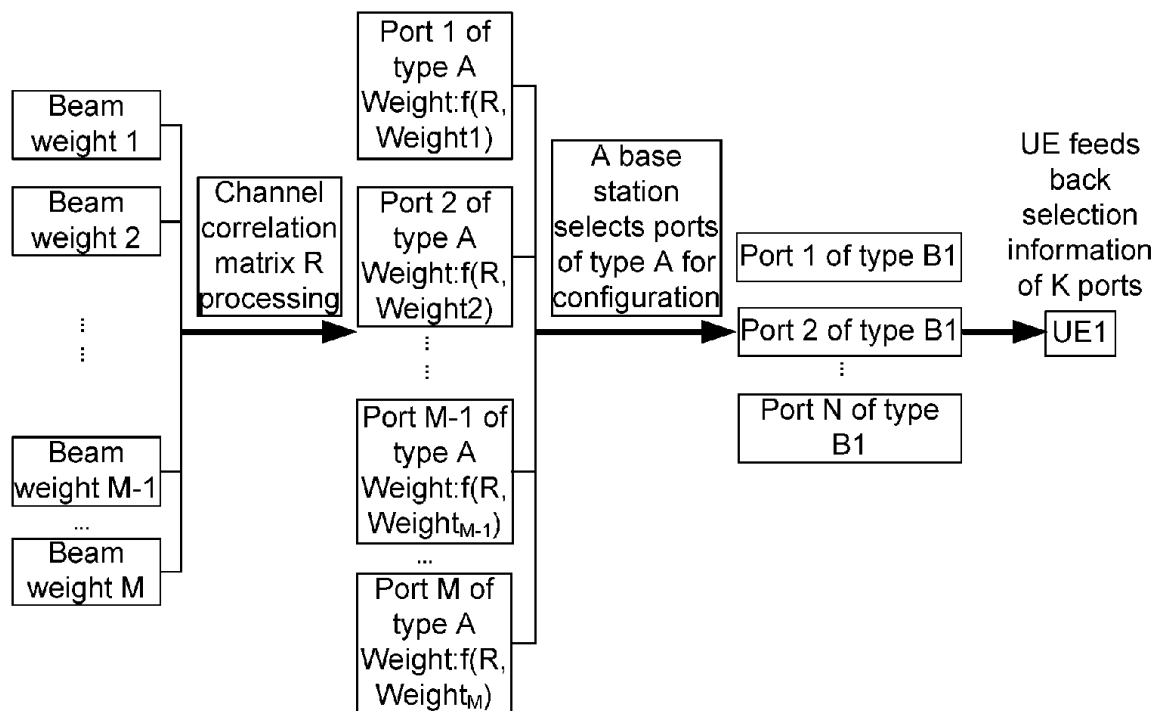


FIG. 12