METHOD AND APPARATUS FOR BEAM SELECTION IN A SMART ANTENNA SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation of U.S application Ser. No. 10/124,541 filed Apr. 16, 2002 now U.S. Pat. No. 7,289,826 titled, "Method and apparatus for beam selection in a smart antenna system" by Omri Hovers et al. assigned to the assignee of claimed and/or disclosed subject matter.

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to the field of wireless communications systems and, more specifically, to a method and apparatus for beam selection in a smart antenna add-on or applique.

BACKGROUND OF THE INVENTION

The rising use of mobile communications systems has led to an increasing demand for enhancing efficiency and performance characteristics, such as increasing network capacity, data rate, signal quality, network coverage, and power efficiency. When a wireless signal is transmitted to a receiver, such as an antenna, the receiver often receives interference along with the signal, making it difficult for the receiver to determine the original signal. This interference may include interference caused by the multipath phenomenon and/or co-channel interference caused by other signals or random noise in the same frequency as the original signal. Smart antenna (SA) systems are designed to reduce these types of interferences, and thus enhance the performance characteristics discussed above.

A smart antenna system is generally located near a base station transceiver and combines an array of antenna elements with digital signal processing capabilities to receive and transmit signals in a spatially sensitive manner. In other words, a smart antenna can adapt the direction of transmissions in response to the signals it receives. Thus, a smart antenna system may be said to track, or follow, mobile communication devices (such as mobile phones or personal digital assistants) as they change their location or active status (such as idle, ready, or standby). For example, when a mobile user is located in a particular location within a sector, the smart antenna system may select a best beam that provides the best coverage for that location and transmit signals to and receive signals from the mobile through that best beam. As the user moves to new locations, the smart antenna system may adapt by switching to the beam or beams that provide the best coverage for those locations.

SUMMARY OF THE INVENTION

In accordance with the present invention, a method and apparatus for beam selection in a smart antenna system are provided that substantially eliminate or reduce the disadvantages and problems associated with previously developed methods and apparatuses.

In one embodiment of the present invention, a method of beam selection in a smart antenna system is provided. The method includes receiving a plurality of uplink beams by a plurality of receivers, each corresponding with one of the plurality of uplink beams. Each uplink beam includes signals transmitted by a mobile station. The method further includes analyzing each of the plurality of uplink beams and selecting an uplink beam from the plurality of uplink beams based at least in part on the analysis of the uplink beams. The method further includes switching to the selected beam in real time to allow the signals communicated in the selected beam to be communicated to a base station transceiver.

In another embodiment, another method of beam selection in a smart antenna system is provided. The method includes receiving signals from a mobile station via a plurality of beams. The signals received via each beam include a signal sequence. The method further includes correlating the signal sequence received via each beam with one or more known training sequences to determine a correlation quality of each beam. The method further includes selecting one or more of the plurality of beams for communication between the mobile station and a base station transceiver based at least in part on one or more parameters including the correlation quality of each of the plurality of beams.

In another embodiment, yet another method of beam selection in a smart antenna system is provided. The method includes receiving signals from a mobile station via a plurality of beams. The method further includes executing a first algorithm to select a first beam from the plurality of beams based at least in part on a first parameter, and executing a second algorithm to select a second beam from the plurality of beams based at least in part on a second parameter. The method further includes determining whether to communicate the first beam or the second beam to a base station transceiver based on one or more selection criteria

Various embodiments of the present invention may benefit from numerous technical advantages. It should be noted that one or more embodiments may benefit from all, some, or none of the advantages discussed below.

One technical advantage includes a smart antenna apparatus operable to reduce the interference, such as multi-path and co-channel interference, associated with uplink signals received by a new or existing base station transceiver. In addition, the smart antenna apparatus may reduce the interference associated with downlink signals received by mobile stations. Thus, the smart antenna apparatus may increase the effective capacity and improve the overall performance of the base station transceiver without requiring any modifications to the base station transceiver. For example, since using narrow beams generally increases the range (or coverage) of effective reception and transmission as compared with wide beams, the smart antenna apparatus may increase the range of the base station transceiver to which it is added. Moreover, the smart antenna apparatus may improve the signal-to-noise ratio (SNR) of transmitted and/or received signals, and thus increases the data rate which may be transmitted and/or received by the base station transceiver.

Another technical advantage includes a smart antenna apparatus operable to determine beam selections based at least in part on a quality factor determined for each of a plurality of uplink beams. The quality factor for each beam may be determined based on one or more parameters, such as a correlation quality of each beam. The correlation quality of each beam is an accurate measurement of the quality of each uplink beam and may also provide an accurate indication of whether an uplink beam comprises a signal from a mobile station or noise from some other source.

Yet another technical advantage includes a smart antenna apparatus operable to select a best beam for uplink communications and a best beam for downlink communications that may be different from the selected best beam for uplink communications, depending on the circumstances. This provides an advantage because the best beam for communicating