Study on Antenna Arrangement of Massive MIMO Using Analog Digital Hybrid Control Method

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In 5th generation mobile communication (5G) systems, small cells using frequencies above the microwave band are introduced for the further frequency utilization efficiency. Massive multiple-input multiple-output (MIMO) transmission technology is proposed as a method to improve the service area and reduce interference with a simple signal processing method, assuming a larger number of users.

In massive MIMO, zero forcing (ZF) is effective because the interference reduction is realized with matrix inversion using the channel matrix. However, when the number of transceivers is the same as the number of antennas used in massive MIMO, the hardware requirements become relatively large to scale. Moreover, the power consumption of A/D and D/A converters is known to increase, especially in high frequency bands.

To solve this problem, an analog digital hybrid control method in which the antenna of the base station is divided into several sub-arrays and maximum ratio combining (MRC) reception is applied for the analog portion for each sub-array is being studied. This method has been clarified to be effective for a massive MIMO configuration, from the viewpoint of transmission quality and reduction of signal processing.

In this paper, the antenna arrangement is evaluated by the channel capacity of massive MIMO applying the analog-digital hybrid method when the base station antenna arrangement is changed from a linear arrangement to a rectangular arrangement. For the small cells which are assumed in 5G mobile communication systems, it is essential to guarantee high transmission quality for each user. In this paper, an antenna arrangement to improve the system capacity when the number of antennas in the vertical and horizontal plane is changed is studied.

In the evaluation, a practical propagation path loss model, which is cited as a 3GPP model, is used. The performance of the channel capacity assuming small cell base stations is evaluated when the arrangement of the antenna elements is changed. The linear arrangement of antenna is shown to have a high channel capacity, because the degree of freedom in the array is important when considering the same number of users as the number of sub-arrays. The channel capacity of vertical antenna arrangement is very close to the channel capacity of horizontal arrangement. Massive MIMO with vertical pattern control is shown to be effective from the point of view of the base station equipment.

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