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EXPLORING THE POSSIBILITY OF IMPROVING THE BANDWIDTH OF MASSIVE MIMO ACCESS CHANNELS BASED MODELING AND EXPERIMENT

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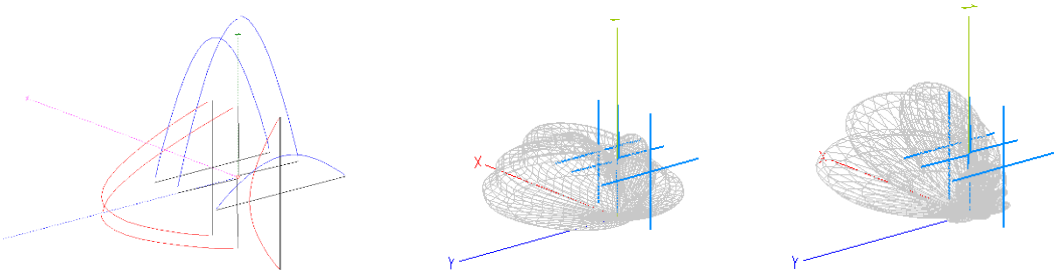
The paper discusses the study of dual polarization integration into massive MIMO access channels to improve overall throughput. The goal is to use the features of polarization parameter distortions of dual polarization antennas and their compensation to improve the parameters of access channels. The study presents a methodology for dual polarization integration using an antenna analysis tool. Experimental results obtained during the implementation of the proposed compensation method, together with a detailed performance analysis, confirm the effectiveness of the developed method for improving the quality parameters of next-generation wireless communication channels with massive MIMO.

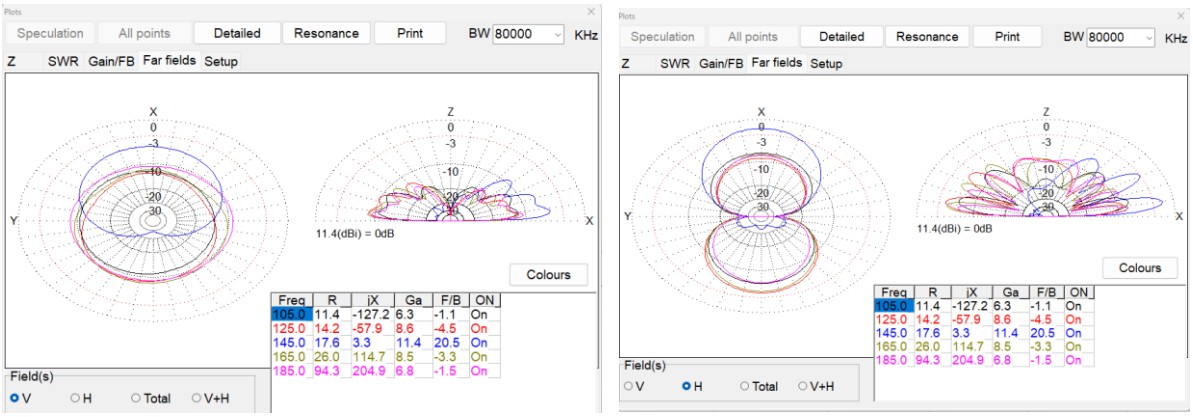
There are known works on the effective implementation of dual-polarization antennas, which can improve the throughput of systems and significantly increase the performance of next-generation communication systems [1]. However, insufficient attention has been paid to the features of their use for Massive MIMO systems. The main limiting factor for positive changes is the significant influence of polarization distortions in dual-polarization antennas, which was not considered in work [2]. The purpose of the study is to analyze the polarization distortions of dual-polarization antennas and take these effects into account in signal processing algorithms and distortion compensation, which was partially considered in work.

Using the MMANA-GAL antenna analysis tool based on the method of moments, we will obtain typical results of studies of various types of antennas, for example, a three-element antenna, which is shown in Figure 1 along with the current distribution of the antenna elements of orthogonal polarization and directivity diagram in vertical (b) and horizontal (c) polarization. We can note that the antenna directivity pattern in space has a complex structure at different polarizations. Taking into account such features of a particular antenna represents the physical basis of the positive effect. Figure 2 shows the cross-section of the directional diagrams E and H by planes in vertical a) and horizontal b) polarization when using a broadband signal. It is worth noting that the nature of the intersection of the E and H planes of the directional diagrams in vertical and horizontal polarization is complex. The diagrams are characteristic of the carrier frequency and a specific frequency band, which is relevant when using a broadband signal.



a) b) c)

Figure 1 – Physical design of the antenna with current distribution (a), directivity diagram in vertical (b) and horizontal (c) polarization



a) b)

Figure 2 – Section of the directional diagrams E and H by planes in vertical a) and horizontal b) polarization when using a broadband signal

Taking these features into account can improve the polarization parameters of a dual-polarization antenna by compensating for distortions in the polarization characteristics of a particular antenna.

An example of compensation for polarization distortions in the required direction of the information consumer can be an algorithm in accordance with the expression

$$E_{compt}(\theta,\varphi,t) = \left(H_{\alpha}^{T*}(\theta,\varphi)H_{\beta}^{T}(\theta,\varphi)\right)^{-1} \cdot E_{t}(\theta,\varphi,t), \quad (1)$$

where the transformation matrices are well described in [2].

We will determine the bandwidth and error probability of a typical dual-channel receiving channel using vibratory antennas. In this case, typical losses of a real channel are taken into account, for example, due to the influence of polarization mismatch and the degree of polarization of radio waves. The frequency band is 20 MHz. Coding is simple binary phase. The error probability was estimated by a statistical method using the developed mathematical model and program of the MIMO channel operation with polarization-orthogonal antennas and taking into account polarization distortions of the signal during radiation, propagation and reception. The number of simulated bits of information

is 1 million, the number of tests is 25. For comparison, we will determine the bandwidth (Figure 3) and error probability (Figure 4) of the proposed channel with compensation for polarization distortions and a real channel with polarization losses, as an example.

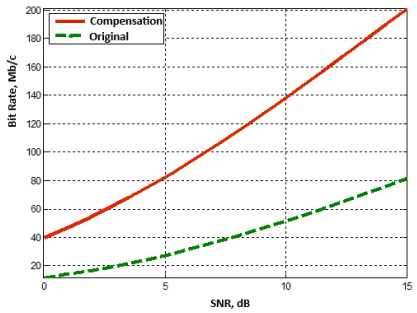


Figure 3 – Channel bandwidth

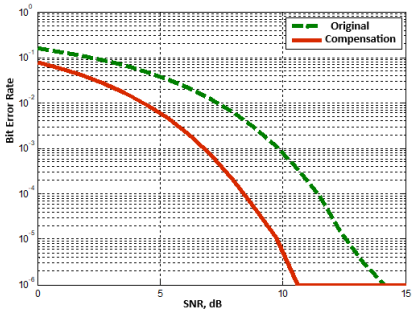


Figure 4 – Channel error probability

Note that if the bandwidth of a real channel with polarization losses and a signal-to-noise ratio reaches a value with an error probability , then for the proposed channel with polarization distortion compensation the bandwidth can already be increased to a value with a lower error probability .

The results of the study indicate the possibility of increasing throughput with a lower probability of errors thanks to the developed proposals, which is of practical significance.

References:

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