Correction of the Amplitude-Phase Distribution of Electromagnetic Field in the Context of Wireless Direction Finding Problem

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Abstract—A technique for correcting the amplitude-phase distribution of the aperture field in the antenna array has been investigated. The optimal number of points for placing the reference oscillator was determined. The specified number provides for achieving the efficiency of superresolution algorithms. A correction technique based on presenting the antenna array in the form of large-radius array consisting of ideal noninteracting elements was proposed. This technique involves the use of only one reference point. Using the MUSIC method, as an example, the direction finding characteristics were calculated for the techniques under consideration.

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Requirements to the accuracy of wireless direction finding have risen significantly nowadays. The issue of enhanced accuracy in determining the angular coordinates becomes urgent for communication applications with digital beam-forming. This is explained by the fact that after the direction-finding bearing measurement it is possible to set the directional pattern nulls on subscribers and enhancing thereby the system carrying capacity [1]. Clearly the radio radiation sources (RRS) bearings should be measured with high accuracy.

The complexity in applying this approach is determined by the fact that the angular separation between subscribers can be less than the Rayleigh resolution limit. What is more, the bearings should be measured in the real-time mode for preventing the reduction of data transmission rate. The conventional direction finding techniques (methods), namely, amplitude and phase ones [2], do not allow us to satisfy both these requirements simultaneously, that is why the superresolution methods based on the algorithmic processing of signals measured at the elements of antenna array (AA) are being actively developed now [1, 3].

The abundance of publications dealing with superresolution methods (see papers [1, 3] and the references in them) makes difficult their comparative analysis. The authors of the present paper developed a software product in the C++ Builder medium using the Matlab 7 mathematical libraries produced by Mathworks Company. This software product based on the Monte Carlo method makes it possible to determine the potential characteristics of superresolution methods: resolution, shifts of bearings, and root-mean-square deviation (RMSD) of bearings. A comparative analysis of the specified methods was conducted using these characteristics [4, 5]. This analysis showed the superiority of the MUSIC algorithm as compared with all the others.

It is a well-known fact that superresolution algorithms are highly demanding with respect to the amplitude-phase errors of receiving channels caused by the mutual interference of antenna elements (AE), errors of antenna-feeder matching, the impact of tower, etc. [6, 7]. Clearly the real direction finding characteristics achieved by using the specified methods are different from the potential characteristics. This being said, the number of papers devoted to the practical implementation of superresolution methods and, consequently, to the estimation of true accuracy is fairly small.

The present paper deals with experimental investigation of the direction finding characteristics by using the superresolution methods and represents the continuation of papers [4, 5].

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