A Novel Model for Direction of Arrival Estimation Using the Phase Center Concept

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Direction of Arrival (DOA) estimation has been studied extensively in literature since the information of DOA is very valuable to numerous applications. The antenna is the first key element of a Direction Finding (DF) system and proper antenna array modeling is required to achieve a high accuracy. More specifically, high angular resolution is required together with reduction of the estimation error for indoor applications. For this purpose, high resolution post processing techniques, such as the MUltiple SIgnal Classification (MUSIC), have been used and proven to have superior performance compared with other amplitude and phase based techniques [1]. However, errors in modeling the antenna array introduce significant errors in the estimation of DOA when using MUSIC or similar techniques [1]. To our knowledge, a major parameter, the phase center (PC) of the antenna, has been neglected so far for the modeling of antenna elements in an array. In this work, the concept of phase center is revisited and the antennas are modeled as a single moving point [2]. This model is used to introduce a new parameter for a more comprehensive and accurate receiver model. The main parameters which determine the location of the phase center are discussed. Analytical derivations and numerical simulations based on the Finite Elements Method (FEM) are employed to study the behavior of the PC. The radiation characteristics of antennas have been proven to have impact on the accuracy of the DOA system [3] without taking into consideration the effect of PC displacement. A complete model, where the effect of the phase center of an antenna is incorporated into DOA estimation in order to improve the accuracy of the mathematical model, is derived. The Cramer Rao Boundary (CRB) is normally used to estimate the performance a DF system [1]. In this work, we include the effect of the in the CRB. We also show superior accuracy in DOA when using MUSIC algorithm simulations and the error in estimation is minimized.

References

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