SVD-based joint azimuth/elevation estimation with automatic pairing

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In this paper, a joint azimuth/elevation estimator with automatic pairing is developed. Two-dimensional (2-D) angle of arrival (AOA) estimation is useful in space processing systems and wireless location systems that employ AOA technology. The estimator makes use of a special setup of the received signal at an L-shaped antenna array element organized especially for the estimation process. The estimator is based on applying the singular value decomposition (SVD) algorithm to a cross-correlation matrix that is constructed from both arrays of the L-shaped structure. The proposed method avoids the computational burden of the complex pair-matching procedure. Simulations of the proposed method are shown to assess its performance.

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1. Introduction

Signal reception from each transmitting source can be enhanced significantly if its angle of arrival (AOA) is known. This is achieved by utilizing the received signal AOA in space processing techniques used to boost the received signal quality [1,2]. In addition, wireless location systems that are based on AOA, such as in [3,4], require accurate AOA measurements. Thus, the importance of the received signals AOA inspired many researchers to develop different techniques to estimate these AOA.

In some applications the direction of the received signal is identified by its azimuth and elevation angles. Thus, it is of interest to estimate the azimuth and elevation angles jointly in a procedure that also pairs the angles automatically for each source. Furthermore, it is of interest to make the estimator have low complexity and high resolution. On the other hand, the antenna array geometry is very important for the two-dimensional (2-D) AOA estimation process. According to [5], the L-shaped antenna array has many advantages over filled rectangular [6] or circular arrays [7] in its coverage area and implementation. Thus, we will assume that the receiver has an L-shaped antenna array positioned as shown in Fig. 1.

ESPRIT or ESPRIT-based algorithms are proposed in the literature to perform the 2-D AOA estimation, such as in [5,8–10]. Also, another method proposed to perform the pairing procedure is the modified propagator method (PM) [7,11]. Although these methods do not require complex searching techniques as in [12–15], they still require pairing techniques in matching the angles estimated. The 2-D AOA estimator proposed in [16] uses two parallel uniform linear arrays (ULAs), whereas, the method in [17] is based on matrix enhancement and the matrix pencil algorithm. The proposed method in [18] constructs a second-order statistic based on the Schur-Hadamard product steering vector to perform the 2-D AOA estimation. In [19], the authors propose an estimator which requires two ULAs to pair the