2-D Unitary Matrix Pencil Method to Estimate the Azimuth and Elevation Angles with New Automatic Pole Pairing Scheme

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In this study, Unitary Transformation for the 1-Dimesional (1-D) Matrix Pencil (MP) Method has been extended to 2-Dimensional (2-D) case to find the direction of arrival angles (DOA), azimuth and elevation, of the signals impinging on planar arrays. The new method has two main advantages over the existing methods; first of all, the new method uses an efficient computational procedure where the computational complexity can be reduced significantly by using real valued computations. By using the Centro-Hermitian property, the complex valued data can be transformed to real valued data, hence reducing the computation time in real time systems. Secondly, the new method does not require pairing algorithm to pair the poles in two-dimensional MP, unlike the other ones do. In many applications, such as direction of arrival, radar imaging, nuclear magnetic resonance imaging or wave number estimation requires the estimation of two-dimensional poles in 2-D data. The Matrix Pencil Method in 2-D case is handled in such a way that the problem is first reduced to 1-D problem, and then the poles related to each dimension are estimated separately and these estimated poles in both dimension must be paired to get the correct pairs which corresponds to correct elevation and azimuth angles for direction of arrival problem. There are different method exists to pair them, but these methods usually require extensive search algorithm in 2-D data, which is computationally expensive. The existing pole pairing method uses the fact that it pairs them by maximizing a given criterion, which does not treat the poles fairly, and creating wrong pairs, hence decreases the performance of the estimator. In our approach, the matrices corresponding to each dimension are written in a special form, and the eigenvalues of this matrix gives the correctly paired poles for the 2-D case, hence the poles are automatically paired, and provide an improved performance. So, instead of finding 1-D poles separately and pairing them, they can be paired simultaneously with this new method. The main advantages of this method are simplicity, and the poles are automatically paired, hence does not require a pairing algorithm. The simulation results show that the new method performs better than the other existing ones, such as the root mean square error (RMSE) of the both estimators has been compared and the new method has a lower RMSE than the other existing method for the low signal to noise ratio (SNR). The other statistical performance parameters are provided to see the performance of the new method.