AN OPTIMAL MIMO SPARSE ANTENNA RECONFIGURATION MODEL FOR ADAPTIVE DOA ESTIMATION USING MULTIPLICATIVE BASIS FUNCTION

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ABSTRACT

Direction-of-arrival (DOA) estimation at an antenna array has gained much interest in array signal processing. The DOA estimation methods have greater significance in most practical and recent engineering applications such as, wireless mobile communications, reconfigurable intelligent surfaces (RIS), sonar, radar, unmanned aerial vehicles (UAV), and drone surveillance and implementations on multiple input multiple output (MIMO) antenna configurations. It determines the direction of multiple superimposed signals in the presence of noise at the antenna array. Accurate DOA estimation helps better signal analysis and noise cancellation in the sparse channel. Nevertheless, a trade-off between flexibility and the estimation performance is mostly unavoidable. This research work addresses the development of accurate DOA estimator that can resolve uncorrelated source signals in the underdetermined criteria for various signal-to-noise ratio (SNR) values. We present an improved DOA estimation method based on the sparse signal reconstruction (SSR) approach. Here, the spatial signals utilized for DOA estimation are reconstructed through a compressive sensing (CS) approach. This CS approach is used to ascertain the adaptive underdetermined DOA for MIMO sparse media on predefined grid values.

Theoretical analysis and practical demonstration of the proposed DOA estimation method are investigated in this research work. Initially, we develop and implement a fine DOA estimation method by leveraging a multiplicative basis function based multi-kernel non-negative sparse Bayesian learning (MK NNSBL). Simultaneously, a virtual stochastic cuckoo search algorithm (CSA) is employed for a minimum redundancy array (MRA) geometry by considering an optimized antenna reconfiguration model. The simulation results demonstrate that the proposed algorithm yields a moderately optimized root mean square error (RMSE) for different optimized wavelengths at randomly generated signals.

Furthermore, a new optimizer is considered because CSA could not result in the least RMSE as expected and could not show robustness. For the proposed multiplicative basis function supported Bayesian framework, a stochastic Grey wolf optimization (GWO) is virtually amended to increase the degrees of freedom (DOF) on a MRA. The advantages of this proposed formulation include the generation of a unique manifold matrix responsible for fine beam steering, resulting in high DOA estimation accuracy. Moreover, addressing the challenge of detecting multiple source signals efficiently. The utilization of CS approach exhibits reduction of errors for various SNR values. Finally, the proposed algorithm implementation results in optimized minimum RMSE for the various optimal wavelengths of the stochastic sources. Ultimately, the overall spectrum analysis and comparative convergence plots exhibits the high potentiality and superiority of the proposed approach over the existing techniques. Notably, there is significant reduction in RMSE which is suitable for precise DOA estimation in wireless communications and signal processing applications.

Keywords: Compressive sensing, Cuckoo search algorithm, DOA, DOF, Grey wolf optimization, Minimum redundancy array, Multiple input and multiple output, Multi-kernel, Non-negative sparse Bayesian learning.