World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:15, No:01, 2021

Optimization Modeling of the Hybrid Antenna Array for the DoA Estimation

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Abstract : The direction of arrival (DoA) estimation is the crucial aspect of the radar technologies for detecting and dividing several signal sources. In this scenario, the antenna array output modeling involves numerous parameters including noise samples, signal waveform, signal directions, signal number, and signal to noise ratio (SNR), and thereby the methods of the DoA estimation rely heavily on the generalization characteristic for establishing a large number of the training data sets. Hence, we have analogously represented the two different optimization models of the DoA estimation; (1) the implementation of the decision directed acyclic graph (DDAG) for the multiclass least-squares support vector machine (LS-SVM), and (2) the optimization method of the deep neural network (DNN) radial basis function (RBF). We have rigorously verified that the LS-SVM DDAG algorithm is capable of accurately classifying DoAs for the three classes. However, the accuracy and robustness of the DoA estimation are still highly sensitive to technological imperfections of the antenna arrays such as non-ideal array design and manufacture, array implementation, mutual coupling effect, and background radiation and thereby the method may fail in representing high precision for the DoA estimation. Therefore, this work has a further contribution on developing the DNN-RBF model for the DoA estimation for overcoming the limitations of the non-parametric and data-driven methods in terms of array imperfection and generalization. The numerical results of implementing the DNN-RBF model have confirmed the better performance of the DoA estimation compared with the LS-SVM algorithm. Consequently, we have analogously evaluated the performance of utilizing the two aforementioned optimization methods for the DoA estimation using the concept of the mean squared error (MSE).

Keywords : DoA estimation, Adaptive antenna array, Deep Neural Network, LS-SVM optimization model, Radial basis function, and MSE

Conference Title : ICRAMET 2021 : International Conference on Radar, Antenna, Microwave, Electronics and Telecommunications

Conference Location : New York, United States

Conference Dates : January 28-29, 2021