Guidelines for Student Reports

PERFORMANCES ANALYSIS OF PSO-BASED OPTIMIZATION PROCEDURES FOR ADAPTIVE NULLING IN TIME-MODULATED LINEAR ARRAYS (MINPWR AND SINR-BASED APPROACHES COMPARISON)

L. Piccardi

Abstract

Nulling techniques in adaptive arrays aim to the maximization of the power received associated to the desired signal despite a minimization of the power associated at the interferences signals, placing nulls in the direction of arrivals (DoAs) of interferences in the synthesis process of the power pattern. Many techniques has been proposed in literature to determine the optimal configuration of the element's excitations based on the maximization of the Signal-to-Noise-plus-Interference-Ratio (SINR-based), or on the minimization of the total power received (MinPwr). In this scenario has been recently proposed an adaptive nulling technique adopting time-modulated linear array: this type of array introduces an additional degree of freedom (time) in the process synthesis increasing flexibility in the antenna design and in the power pattern shaping problem. The major inconvenient of time-modulated arrays is the generation of unwanted harmonics, the so called sideband radiation that represent a loss in term of radiated power. This project proposes study through a comparison of two techniques (SINR-based and MinPwr) based on the particle swarm algorithm to determine the optimal dynamic configuration of the array excitations in order to receive correctly the desired signal minimizing the interferences contributes and in the same time limiting the drawbacks of time-modulated array (stated before) considering a time-varying scenario: particle swarm algorithm shown its effectiveness in electromagnetics problems solution, in particular on the problem of synthesis of adaptive arrays in time-varying scenarios and on the problem time modulated array synthesis with low SR.

Reference Bibliography: Evolutionary Optimization, Array Synthesis and Time Modulated Arrays [1]-[9]; Evolutionary Optimization [10]-[12].

[1] P. Rocca, L. Poli, G. Oliveri, and A. Massa, "A multi-stage approach for the synthesis of sub-arrayed time modulated linear arrays," IEEE Trans. Antennas Propag., vol. 59, no. 9, pp. 3246-3254, Sep. 2011.

[2] L. Poli, P. Rocca, G. Oliveri, and A. Massa, "Harmonic beamforming in time-modulated linear arrays," IEEE Trans. Antennas Propag., vol. 59, no. 7, pp. 2538-2545, Jul. 2011.

[3] P. Rocca, L. Poli, G. Oliveri, and A. Massa, "Adaptive nulling in time-varying scenarios through time-modulated linear arrays," IEEE Antennas Wireless Propag. Lett., vol. 11, pp. 101-104, 2012.

[4] P. Rocca, L. Poli, and A. Massa, "Instantaneous directivity optimization in time-modulated array receivers," IET Microwaves, Antennas & Propagation, vol. 6, no. 14, pp. 1590-1597, Nov. 2012.

[5] L. Poli, P. Rocca, and A. Massa, "Sideband radiation reduction exploiting pattern multiplication in directive time-modulated linear arrays," IET Microwaves, Antennas & Propagation, vol. 6, no. 2, pp. 214-222, 2012.
[6] L. Poli, P. Rocca, G. Oliveri, and A. Massa, "Adaptive nulling in time-modulated linear arrays with minimum power losses," IET Microwaves, Antennas & Propagation, vol. 5, no. 2, pp. 157-166, 2011.
[7] P. Rocca, L. Poli, G. Oliveri, and A. Massa, "Synthesis of time-modulated planar arrays with controlled harmonic radiations," Journal of Electromagnetic Waves and Applications, vol. 24, no. 5/6, pp. 827-838, 2010.
[8] P. Rocca, L. Manica, L. Poli, and A. Massa, "Synthesis of compromise sum-difference arrays through time-modulation," IET Radar, Sonar & Navigation, vol. 3, no. 6, pp. 630-637, 2009.
[9] L. Poli, P. Rocca, G. Oliveri, and A. Massa, "Failure correction in time-modulated linear arrays," IET Radar, Sonar & Navigation, vol. 8, no. 3, pp. 195-201, 2014.
[10] P. Rocca, G. Oliveri, and A. Massa, "Differential Evolution as applied to electromagnetics," IEEE Antennas Propag. Mag., vol. 53, no. 1, pp. 38-49, Feb. 2011.

This report is submitted in partial fulfillment of the degree of the course "ACM".
Supervisors: Prof. Andrea Massa, Dr. Lorenzo Poli.