Guidelines for Student Reports

SYNTHESIS OF TIME-MODULATED LINEAR ARRAYS WITH QUANTIZED ON-TIME FOR SECURE COMMUNICATIONS

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Abstract

In the last years, time-modulated arrays have gained a growing interest since they overcome some classical drawbacks of the amplitude-weight control by arbitrarily shaping the radiated pattern by means of the modulation of the static excitations with a set of radiofrequency (RF) switches. Nevertheless, two main problems have limited the consideration of this type of array in the past: the necessity to use reliable RF switches operating at high frequency, and the generation of unwanted harmonics, the so called sideband radiation (SR), which represent a loss in term of radiated power. The new generation of RF switches thanks to the recent advance in nano-technologies are able to satisfy the operative requirements; moreover, the use of global optimization algorithms have shown that the problem of the sideband radiation can be properly handled.

In the recent years, time-modulated arrays have been studied by a new perspective in which part of the sideband radiation is exploited for useful purposes. In this framework, this project is aimed to propose a novel synthesis technique for security applications based on a customized version of the genetic algorithms. More in detail, the modified-GA developed in leterature will be exploited to determine suitable pulse sequences (with quantized/splitted on-time) to keep fixed the instantaneous directivity during the modulation period, in order to nullify the sideband radiation (SR) along the direction of the desired signal and to exploit the SR to encrypt the signal radiated in the sidelobe region.

Reference Bibliography: Evolutionary Optimization [1]-[2]; Evolutionary Optimization, Array Synthesis and Time Modulated Arrays [3]-[12].

[1] P. Rocca, M. Benedetti, M. Donelli, D. Franceschini, and A. Massa, "Evolutionary optimization as applied to inverse problems," Inverse Problems - 25 th Year Special Issue of Inverse Problems, Invited Topical Review, vol. 25, pp. 1-41, Dec. 2009.

[2] 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.

[3] E. T. Bekele, L. Poli, M. D'Urso, P. Rocca, and A. Massa, "Pulse-shaping strategy for time modulated arrays - Analysis and design," IEEE Trans. Antennas Propag., vol. 61, no. 7, pp. 3525-3537, July 2013.

[4] 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.

[5] L. Poli, P. Rocca, L. Manica, and A. Massa, "Handling sideband radiations in time-modulated arrays through particle swarm optimization," IEEE Trans. Antennas Propag., vol. 58, no. 4, pp. 1408-1411, Apr. 2010.

[6] 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.
[7] P. Rocca, L. Poli, L. Manica, and A. Massa, "Synthesis of monopulse time-modulated planar arrays with controlled sideband radiation," IET Radar, Sonar & Navigation, vol. 6, no. 6, pp. 432-442, 2012.
[8] 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.
[9] L. Poli, P. Rocca, L. Manica, and A. Massa, "Time modulated planar arrays - Analysis and optimization of the sideband radiations," IET Microwaves, Antennas & Propagation, vol. 4, no. 9, pp. 1165-1171, 2010.
[10] L. Manica, P. Rocca, L. Poli, and A. Massa, "Almost time-independent performance in time-modulated linear arrays," IEEE Antennas Wireless Propag. Lett., vol. 8, pp. 843-846, 2009.
[11] 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.
[12] L. Poli, P. Rocca, G. Oliveri, and A. Massa, "Failure correction in time-modulated linear arrays," IET Radar, Sonar & Navigation, in press.

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