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Application of innovative Evolutionary Algorithms to the design of aperiodic arrays

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The design of an aperiodic arrays, as the thinned or the non-uniform ones, has been approached with several different techniques. Among the others, those based on the use of Evolutionary Algorithms (EAs) seem very promising [1-3], since they allow to determine "automatically" the best distribution of the switched-on elements and/or their position and excitation.

In most of the cases, the problem is described as a single objective one, where the specifications on the radiation pattern, and in particular on the Side Lobe Level (SLL), have to be fulfilled. In this situation, the number of element N is fixed a priori and the optimization algorithm act on the position and the excitation of the switched-on elements. Referring for instance to the case of a sparse array, the common procedure is that of minimizing the SLL, with the minimum number of iterations; the most popular EAs often fail in pursuing this goal, and therefore other, more efficient techniques must be adopted, as the M_QC_{10}-BBO, an enhanced version of the Biogeography Based Optimization, that has already shown good performances in the optimization of antenna problems [4]. The curves of convergence relative to the optimization of a 16×16 planar thinned array plotted in Fig.1 proves that the proposed method outperforms more conventional techniques

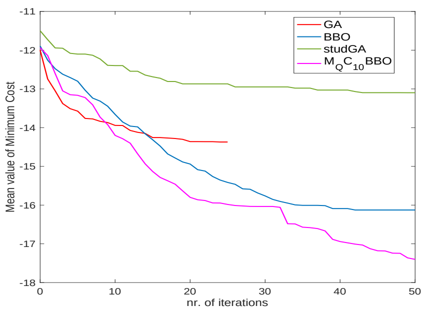

Figure 1. Convergence of several algorithms applied to the optimization of a planar thinned array.

To guarantee that the optimized array configuration is that with the minimum complexity, another parameter has, however, to be also considered, the number of array elements switched-on, that must be the minimum possible. In this way, the problem becomes a multi-objective ones, since the minimization of *N* and of the SLLs are targets conflicting each other and a trade-off between them must be found. In [5] some preliminary results on the application of the Social Network Optimization, a quite recent algorithm that mimics the behavior of a social network to this problem are summarized. At the conference time, more details on its implementation and application to several cases of both thinned and not uniform arrays will be presented. A comparison between the two proposed techniques will be also carried on.

References

[1] R. L. Haupt, "Thinned arrays using genetic algorithms," *IEEE Trans. Antennas Propag.*, vol. 42, no. 7, pp. 993–999, 1994.
[2] G. Oliveri, A. Massa, "Genetic Algorithm enhanced almost difference set based approach for array thinning," *IET Microwave, Antennas & Propagation*, vol. 5, pp. 305-315, 2011.
[3] M. Ridwan, M. Abdo, E. Jorswieck, "Design of non-uniform antenna arrays using genetic algorithm," *13th Int. Conference on Advanced Communication Technology (ICACT2011)*, Seoul, 2011, pp. 422-427.
[4] P. Pirinoli, A. Massaccesi, M. Beccaria, "On the use of MmCn-BBO for Antenna Problems Optimization," *2018 IEEE Int. Symposium on Antennas and Propag.*, Boston, MA, 2018, pp. 537-538.
[5] F. Grimaccia, M. Mussetta, A. Niccolai, P. Pirinoli, R.E. Zich, "SNO multi-objective implementation for sparse array optimization," *2017 Int. Conf. on Electrom. in Adv. Appl. (ICEAA)*, Verona, 2017, pp. 824-827.