SETSCI Conference Indexing System, Volume 2 (2018), 251-251

ISAS 2018

1st International Symposium on Innovative Approaches in Scientific Studies

# Pattern Nulling of Linear Antenna Arrays Using Salp Swarm Algorithm

Kerim GUNEY[1], Erhan KURT [1]*, and Ali DURMUŞ[2]

[1]*Department of Electrical and Electronics Engineering, Faculty of Engineering, Nuh Naci Yazgan University, Turkey*
[2]*Department of Electricity and Energy, Vocational College, Erciyes University, Turkey*
**ekurt@nny.edu.tr*
**Corresponding author: ekurt@nny.edu.tr*
+*Speaker: *ekurt@nny.edu.tr*
*Presentation/Paper Type: Oral / Abstract*

***Abstract-*** A useful and flexible method based on the salp swarm algorithm (SSA) for the pattern nulling of linear antenna arrays with the prescribed nulls is presented. SSA is a relatively new population based evolutionary optimization algorithm. Nulling of the pattern is achieved by controlling the amplitude-only, the phase-only, and the positiononly. Some examples of Chebyshev array pattern with the imposed single and multiple nulls are given.

Due to the increasing pollution of the electromagnetic environment, the antenna array, which allows placingnulls in the far field pattern at prescribed directions, is becoming important in radar, sonar and many communication systems for maximizing signal-to-interference ratio. Pattern nulling techniques available in the literature include controlling the amplitude-only, the phase-only, and the position only. These techniques have been extensively studied in the literature. In recent years, the metaheuristic algorithms have received remarkable attention for the null steering in antenna array patterns. These metaheuristic algorithms are more flexible than traditional methods and do not use progress information. Additionally, the metaheuristic algorithms are capable of escaping from local minima. For this reason, in this study SSA is used for linear antenna pattern nulling. The inspiration of SSA is the swarming behaviour of salps when navigating and foraging in oceans. Salps belong to the family of Salpidae and have transparent barrelshaped body. Their tissues are almost the same as those of jelly fishes and move like them.

Let us assume that the array elements are symmetrically placed and conjugate-symmetrically excited about the center of a linear array. The far field array factor of such an array with an even number of isotropic elements (2N) is defined as

$$AF(\theta) = 2\sum_{k=1}^{N} a_k \cos\left(\frac{2\pi}{\lambda} d_k \sin\theta + \varphi_k\right)$$

where $\theta$ is the angel from broadside, *dk* is the distance between position of the kth element and the array center, and *ak* and *φk* are amplitude and phase weights of the k*th* element, respectively.

The main aim of the study is to find a set of optimum element amplitude, phase, or position values in order to produce a radiation pattern with low maximum side-lobe level (MSL) and depth nulls placed in desired directions. Therefore, the following cost function will be minimized with the use of SSA.

$$C = \sum_{\theta=-90^0}^{90^0} \left[ W(\theta) \left| F_o(\theta) - F_d(\theta) \right| + ESL(\theta) \right]$$

where Fo($\theta$) and Fd($\theta$) are, respectively, the pattern obtained by using SSA and the desired pattern. W($\theta$) and ESL($\theta$) are included in the cost function to control the null depth level (NDL) and maximum sidelobe level (MSL), respectively.

Numerical results show that the SSA is capable of synthesizing the array patterns with single, multiple, and broad nulls imposed at the directions of interferences. The results also show that SSA is a fast evolutionary algorithm and it can produce flexible solutions for antenna array optimization problems. SSA method will likely be an attractive alternative in the electromagnetics and antennas community.

*Keywords- linear antenna array, salp swarm algorithm, pattern nulling, maximum sidelobe level, null depth level*