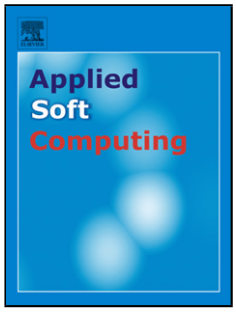

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Author: K.R. Subhashini J.K. Satapathy

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Development of an Enhanced Ant Lion Optimization Algorithm and its Application in Antenna Array Synthesis

K.R.Subhashini[a], J.K.Satapathy[a,*]

[a]*Department of EE,NIT ROURKELA,INDIA*

Abstract

In order to design a highly effective communication system, antenna plays a vital role and antenna array adds to the performances. And to achieve such a goal, the crucial challenge is to determine the optimum spacing between the elements and their excitations. In order to address this issue a novel optimization technique named as enhanced ant lion optimization (e-ALO) algorithm has been developed by modifying the basic Ant lion optimization algorithm. Further, to validate the efficacy of the proposed algorithm, few benchmark functions have been successfully tested and significant improvement is obtained in comparison to other reported optimization approaches. The proposed scheme is applied to antenna array synthesis problem to optimize the inter-element spacing and excitation of the elements for different antenna geometries, with an objective to minimize the sidelobe levels while keeping other constraints within boundary limits. The encouraging results obtained from the study has emphatically placed the proposed e-ALO algorithm in the optimization arena as a dominant player.

Keywords: antenna, sidelobe level, Antlion optimization, Optimization, Null depth.

1. Introduction

Antenna is a key element in any communication network and its design really dictates the performance in reducing sidelobe level and placing the nulls at prescribed locations while satisfying the constraints of assured gain and directivity [1–5]. Antenna arrays have been widely used in mobile, wireless, satellite and radar communications systems to improve signal quality, thereby increasing system coverage, capacity and link quality. The performance of these systems depends firmly on the antenna array design[6–11]. Such compulsions pave the way for choosing the proper geometrical configurations either linear arrays or circular arrays. And in order that these antenna arrays deliver the relevant performances, judicious design must be carried out to fulfill the desired objectives. This necessitates finding optimum values corresponding to the spacings between antenna elements and their excitations. However the ever demanding task which always remains as a focal point to address such issues is the application of appropriate mathematical tool known as optimization techniques. Being fascinated by the encouraging result of various nature-inspired metaheuristic optimization algorithms, researchers have successfully applied these to antenna array problems and achieved enhanced performances. The conventional algorithms based on error-derivative optimization techniques suffer from drawbacks of not converging to global optima, clearly indicating that the solution is being trapped in the local minima. Such results further reinforces the idea that these algorithms are highly susceptible to initial conditions. But the developments of nature inspired metaheuristic algorithms are capable handling such issues[7, 12–17]. Both linear antenna array and circular antenna array find wide applications in varieties of communication networks. Various metaheuristic approaches in designing antenna arrays of different geometrical topologies have been well documented [18–30] . The work proposed in this paper is a variant of the recently reported metaheuristic optimization technique known as Ant Lion Optimization (ALO)[31] algorithm. And this novel approach is named as enhanced Ant Lion Optimization (e-ALO) algorithm. The central theme of this algorithm revolves round the main character, the antlion, who has developed a unique hunting strategy inspired by nature. These antlions with their embedded intelligence out manoeuvre the ants by making them their

*Corresponding author

Email addresses: subhashiniratna@gmail.com (K.R.Subhashini), jks98v@yahoo.com (J.K.Satapathy)