Optimization Design of Log-periodic Dipole Antenna Arrays Via Multiobjective Genetic Algorithms

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Abstract：

Genetic algorithms (GA) is a well known technique that is capable of handling multiobjective functions and discrete constraints in the process of numerical optimization. Together with the Pareto ranking scheme, more than one possible solution can be obtained despite the imposed constraints and multi-criteria design functions. In view of this unique capability, the design of the log-periodic dipole antenna array (LPDA) using this special feature is proposed in this paper. This method also provides gain, front-back level and S parameter design tradeoff for the LPDA design in broadband application at no extra computational cost.

Key words: LPDA , multiobjective optimization, Genetic algorithm*, broadband.*

1.0 Introduction

This paper is to fully mimic the natural selection of Genetic algorithms that can search a global solution for a LPDA design. A number of design objective functions are independently established for the use of classifying the performance with the Pareto ranking scheme that meets all the design criteria. The advantage of such methodology, is its capacity to find more than one solution that are unique and amiably be adoptable for practical application.

2. 0 The method of moment solution of LPDA

The structure of LPDA can be seen in Fig.1. The LPDA is considered as a boundary value design problem represented by a set of integral equations governing the current distribution on the dipoles. In General, the LPDA performance could be adequately evaluated by the MoM.

3.0 MOGA approach on LPDA Design

In this paper, instead of the using the conventional heuristic approach for solving this highly constrained but multi-criteria problem, a MOGA approach is proposed.

There are 3 factors for optimization, the scale factor t , the spacing factor s and g .

The objectives for the optimization are (i) to obtain the lowest S_{11} magnitude and linear S_{11} phase; (ii) to be able to yield the highest gain; and (iii) to reach the highest front-back level (dB).

A Pareto set of solutions becomes available and more than one solution can be freely chosen should they meet the fulfillment of system requirements.

4. Results

In order to verify the effective of the MOGA in LPDA design, we present the results of the LPDA using MOGA and other methods. A 8-element LPDA is selected for the design. The LPDA has the feeder characteristic impedance $Z_f = 50\ \Omega$, and a short circuit termination impedance at a distance of ¼ wavelength measured from the position of longest dipole.

The ranges of the parameters in MOGA and CGA are the same, $t \in [0.75, 0.95]$, $s \in [0.08, 0.21]$, $g \in [15, 100]$.

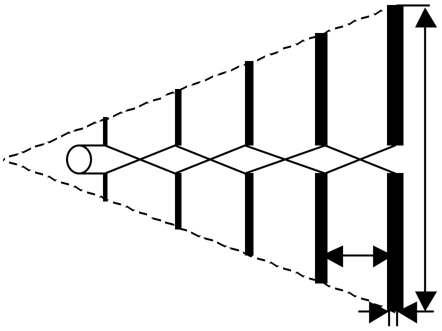

Fig.1.The profile of the LPDA

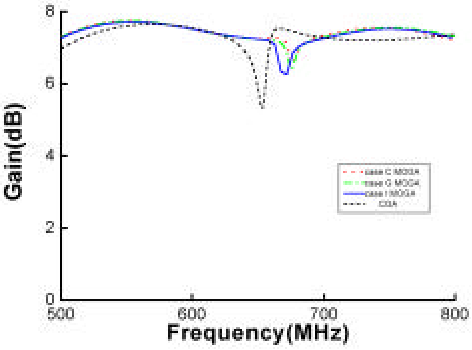

Fig.2. The Gain vs Frequency

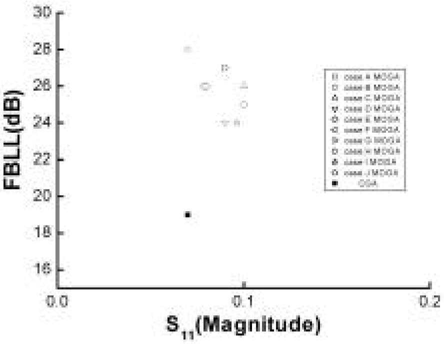

Fig 3 The FBLL vs S parameter

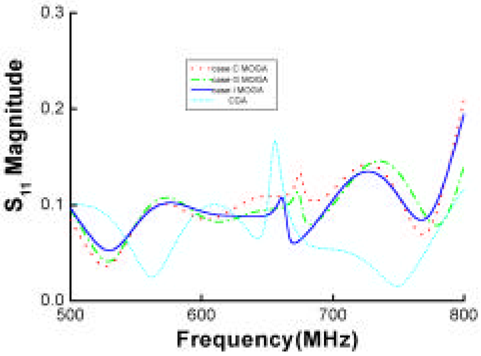

Fig .4. The S parameter vs frequency

The gain vs frequency (including the CGA)are displayed in Fig.2. In the event of S_{11} which includes the amplitude characteristic is displayed in Fig.3and Fig.4, Albeit from the CGA result that are somewhat lower than those of MOGA in most frequencies as shown in Fig.3 and Fig.4, the S_{11} amplitudes by

MOGA and CGA are all below 0.2. This corresponds to VSWR at 1.5.

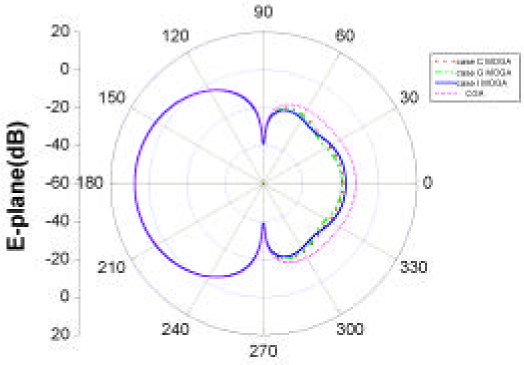

Figure 5 E-Plane Pattern of LPDA

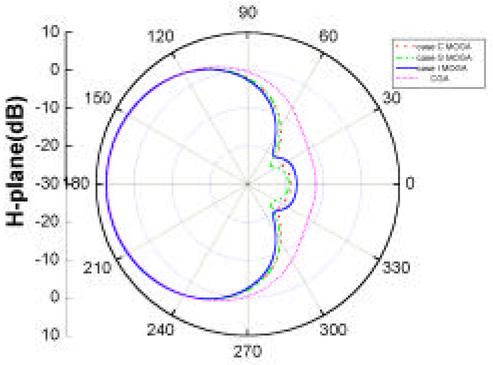

Fig.6.H-Plane Pattern of LPDA

The E-plane and H-plane patterns for both MOGA and CGA are shown in Fig.5 and Fig.6 respectively. The difference in E-plane for the two methods is not markedly distinguishable with only 2dB in the back lobe. But the difference in H-plane is far more notable, especially in the back lobe region. Their difference could reach to 5dB as suggested by the results indicated in Fig.6.

Another important phenomenon has been sprung off from this design practice is that the values of t , s and g of the MOGA particularly for *case* A to *case* J are deviated greatly from the one obtained by CGA. The most noticible is in the g value. As a result, this signifies that the MOGA could provide more possible solutions to the LPDA design rather than that of CGA when practical proposition becomes a reality.

5. Conclusion

The LPDA array has been successfully designed using MOGA methodology. It is demonstrated that this approach is capable of identifying the scale factor t , the spacing factor s and the ratio of dipole length to diameter g . With the use of the Pareto ranking treatment of objective functions, the trade off exercise between the gain, S_{11} and FBLL is now a realistic proposition for the design. Furthermore, the MOGA provide more candidates of solutions to the LPDA design than CGA. It is a value-added feature which allows greater design flexibility for the designer in making the right choice in terms of performance.

Acknowledgement

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Reference:

[1] D.E.Goldberg, Genetic Algorithms in search , optimization, and Machine Learning[M], Addision-Wesley, Reading, Mass.,1989

[2]K.F.Man,K.S.Tang and S.Kwong,Genetic Algorithms, Springer, 1999