REVIEW OF RESEARCH
IMPACT FACTOR : 5.7631(UIF) UGC APPROVED JOURNAL NO. 48514 ISSN: 2249-894X
VOLUME - 8 | ISSUE - 4 | JANUARY - 2019

STUDY OF ARTIFICIAL NEURAL NETWORKS FOR BROADBAND ANTENNA BASED ON A PARAMETRIC FREQUENCY MODEL

Rajeev Kumar Sharma
Dept. of Physics, L.N.Mithila University, Darbhanga.

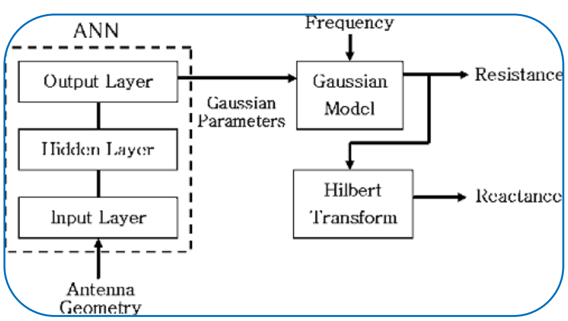
ABSTRACT :

In this paper neural network (ANN) is planned to predict the input electric resistance of a broadband antenna as an operate of its geometric parameters. The input resistance of the antenna is initial parameterized by a mathematician model, and therefore the ANN is built to approximate the nonlinear relationship between the antenna pure mathematics and therefore the model parameters. A hybrid gradient descent and particle swarm optimization methodology is employed to coach the neural network. The antenna structure is then optimized for broadband operation via a genetic algorithmic program that uses input electric resistance estimates provided by the trained ANN in situ of brute-force magnetic attraction computations. it's found that the specified range of magnetic attraction computations in coaching the ANN is 10 times less than that required throughout the antenna optimization method.

KEYWORDS : *Broad band antenna, Artificial neural network, brute-force, Gaussian Model.*

INTRODUCTION

Microstrip antennas (MSAs) are employed in a broad vary of applications from communication systems to medical specialty systems, primarily thanks to their simplicity, conformability, low producing price, lightweight weight, low profile, duplicability, dependableness, and ease in fabrication and integration with solid-state devices. the look of broadband antennas could be a computationally intensive task, particularly once a frequency-domain magnetic attraction (EM) machine is employed. Moreover, once associate optimization technique like a genetic rule [1] is employed within the style method, the antenna characteristics should be computed for thousands of hypothetic antennas over a broadband of frequencies so as to guage the relative benefit of every configuration. so as to substitute the computationally intensive EM simulation, artificial neural networks (ANNs) [2-3] are prompt as enticing alternatives [4]. Associate ANN will be appropriate for modeling high- dimensional and extremely nonlinear issues. once properly trained with reliable learning knowledge, a neuromodel is computationally a lot of economical than a particular EM machine, and a lot of correct than a model supported approximate physics. Thus, the neural network approach has been explored within the style of microwave elements and circuits like microstrip lines [5], spiral inductors, HEMT , filters , and mixers [6]. within the antenna community, ANN has been applied to beam forming and direction-finding for arrays, yet on microstrip antenna style. However, the utilization of ANN for terribly broadband antennas with multiple resonances has not been extensively researched however. In this paper, we tend to use a neural network for predicting the input electric resistance of a broadband antenna via a constant frequency model. The



input resistance of the antenna is 1st parameterized by a Gaussian model. The Gaussian parameters are then calculable for the various coaching antennas and a neural network is trained to explain the link between the antenna pure mathematics and the Gaussian parameters, as shown in Fig. 1. By introducing the constant model, the ensuing ANN operates in an exceedingly abundant less complicated answer area. This ends up in a smaller network size, quicker coaching time, and a lot of sturdy convergence of the coaching method. For the coaching technique, a hybrid theme combining the gradient descent technique and a particle swarm optimization is employed. Once the network for the input resistance is in situ, the input electrical phenomenon is generated by the mathematician rework. This planned technique is valid once the band of interest is broad and therefore the resonant frequencies of the antenna are distinct. The ensuing neural model is next exploited for antenna optimization. During this paper, we tend to use the loop-based broadband associate antenna structure rumored in as an example. The antenna has seven geometric parameters: the lengths and heights of its 3 rectangular standardization arms and therefore the radius of the antenna wire. The antenna structure is optimized for broadband operation via a genetic rule (GA) that uses the input electric resistance foretold by the ANN over a broad frequency vary and over the vary of antenna geometries being thought-about by the GA. The performance of the ANN in terms of accuracy and machine savings is evaluated during this application against a brute- force electromagnetic computation.

GAUSSIAN-BASED FREQUENCY MODEL FOR INPUT RESISTANCE:-

The input resistivity of a broadband antenna sometimes contains multiple resonances inside the band of interest. An instantaneous approximation of this characteristic by a neural network might result in an oversized range of hidden units and is at risk of failure. What is more, the forceful amendments in electrical phenomenon at the resonant frequency are often troublesome for the ANN to be told. so as to modify the matter, we have a tendency to engraft an acceptable physical principle into the network thus on constrain the answer house. We choose to model the resistance by a total of Gaussians. The Gaussian model is easy and comparatively insensitive to parameter errors.

Furthermore, modeling only the resistance behavior leads to a reduced network size, improved training time, and better chance of successful training. Once the broadband resistance is modeled, the reactance can be recovered via the Hilbert transform. A Gaussian model to approximate the frequency dependent resistance envelope of a symmetric resonator can be represented as

$$\mathrm{Re}(Z(f))_k = \left({}^{X} c_l^{\left(\frac{(f - b_k)^2}{a_k}\right)} \right) + d. \qquad \text{-------} \ (1)$$

Here, Z(f) is the impedance function; , and are coefficients of the model; and is a bias.

ARTIFICIAL NEURAL NET STRUCTURE:-

An artificial neural network is next constructed to model the complex relationship between the antenna geometry and the Gaussian model parameters. For modeling the antenna geometry, the multilayered perceptron (MLP) is utilized. The MLP is a known universal approximator and has been extensively used in microwave applications . The suggested network system is illustrated in Fig.1.

A broadband antenna for automobiles, reported earlier in, is considered as an example. It is a loop structure with three tuning arms as presented in Fig.2.

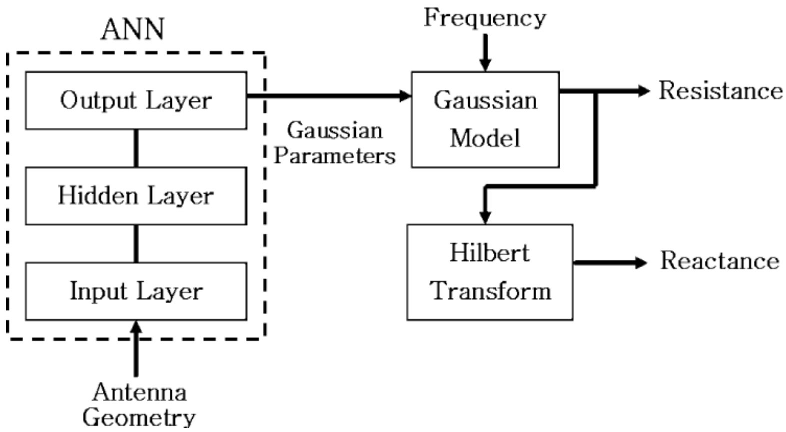


Fig. 1. Impedance prediction network.

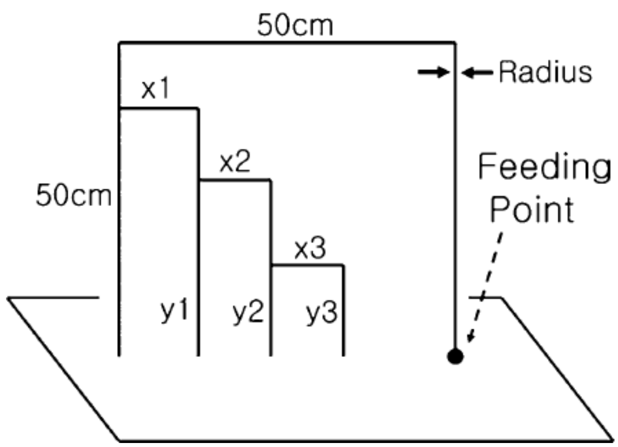


Fig. 2. Antenna shape and parameters.

BROADBAND ANTENNA OPTIMIZATION USING ANN:-

The performance of the trained ANN is evaluated through an antenna optimization process. A GA is used to optimize the considered broadband antenna structure. In the process of the GA, the antenna impedances are generated by the trained ANN rather than by an EM simulator, as depicted in Fig. 3. The resistance is calculated using the trained neural network, and the reactance is derived from the Hilbert transform.

The ANN result agrees fairly well with the NEC calculation. Their corresponding VSWR curves are plotted in Fig. 2. The dashed curve is the "GA with ANN" result and the solid curve is the true VSWR of the optimized design as calculated by NEC. The averaged VSWR as computed by NEC is 1.63 in the band of interest (the unshaded regions in the plot).

In order to gauge the performance of the developed ANN, the considered antenna is optimized again by the GA, this time using brute-force calculations by NEC for all the cost function evaluations. The GA converges after29 iterations. The best cost in the optimization process is 1.64. Due to the difference in the exact NEC calculation and the ANN prediction, the GA this time converges to a slightly higher optimized cost and a different optimized antenna configuration. In Fig.4, we plot the VSWR of this optimized antenna configuration as the dotted curve. We observe that the performance of the "GA with NEC" antenna is comparable to that of the "GA with ANN"antenna.

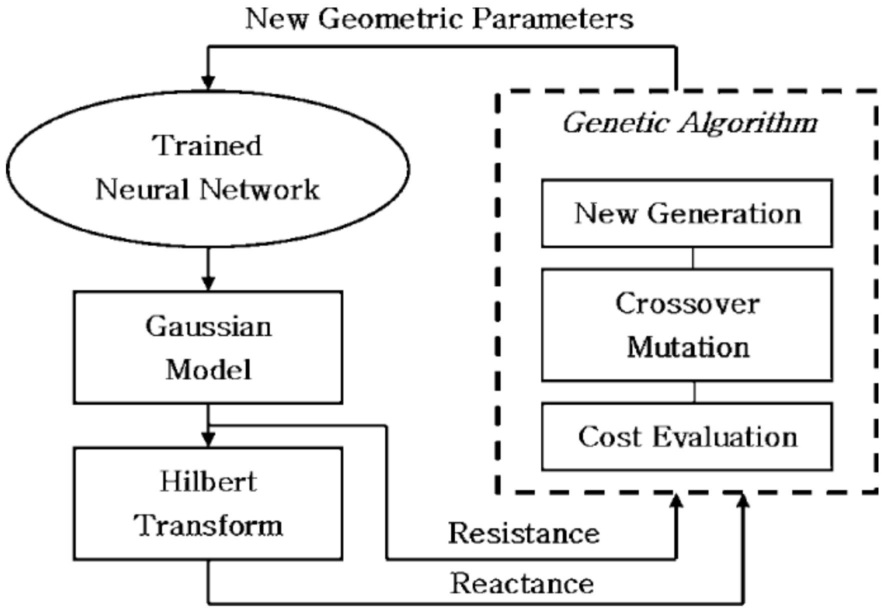


Fig. 3. Genetic algorithm with the ANN.

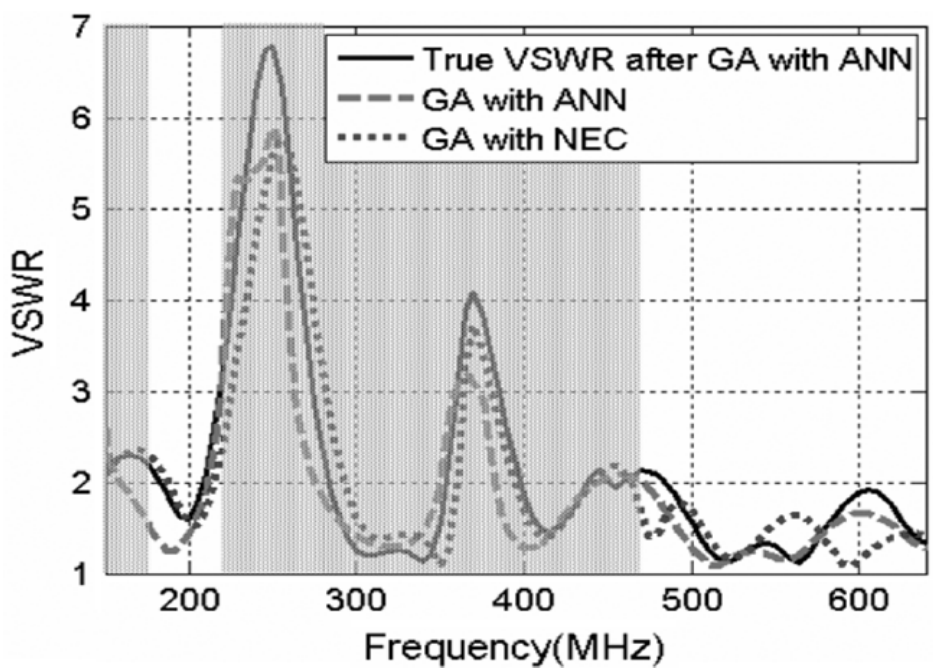


Fig. 4. VSWR of the optimized antenna.

CONCLUSION:-

An ANN-based system has been planned to predict the input ohmic resistance of a broadband antenna. The input resistance of the antenna was initial parameterized by a mathematician model over a broad band of frequencies and therefore the ANN was then made to approximate the nonlinear relationship between the antenna pure mathematics and therefore the model parameters. Introducing the model simplified the development and coaching of the ANN, leading to strong performance. The neural network was trained by mistreatment particle swarm optimization as a neighborhood search procedure seeded with associate degree initial guess from the gradient descent learning. The electrical phenomenon of the antenna was then made by the mathematician remodel. to check the performance of the ensuing ANN, a loop antenna with multiple standardization arms was optimized by aGA, where by the developed ANN system was used forthecost function evaluations. The performance of the ANN was compared with that of a direct approach, in which the cost function evaluation was done using the EM simulator. This indicates that a parametric frequency model used in conjunction with an ANN forms an effective framework for the design and evaluation of very broadband antennas. While the Gaussian model is found to perform adequately, other frequency models such as the rational function model may lead to even better performance.

REFERENCES:-

[1] R.L.Haupt,"An introduction to genetic algorithms for electromagnetic," IEEE Antennas Propag. Mag., vol. 37, pp. 7–15, Apr.1995.

[2] C. Bishop, Neural Networks for Pattern Recognition. Oxford, U.K.: Oxford Univ. Press,1995.

[3] Q. Zhang, K. C. Gupta, and V. K. Devabhaktuni, "Artificial neural networks for RF and microwave design—From theory to practice," IEEE Trans. Microwave Theory Tech., vol. 51, pp. 1339–1350, Apr.2003.

[4] A. Patnaik, D. E. Anagnostou, R. Mishra, C. G. Christodoulou, and J. C. Lyke, "Applications of neural networks in wireless communications," IEEE Antennas Propag. Mag., vol. 46, pp. 130–137, Jun.2004.

[5] J. Li and Z. Bao, "Neural network models for the coupling microstrip line design," in Proc. IEEE Int. Conf. Syst., Oct. 2003, vol. 5, pp.4916–4921.

[6] A. Ilumoka and Y. Park, "Neural network-based modeling and design of on chip spiral inductors," Proc. 36th Southeastern Symp. Syst. Theory, pp. 561– 564,2004.