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Design of E-shaped microstrip patch antenna using Artificial neural network

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Abstract- This paper presents E-shaped microstrip patch antenna with wideband remote applications. A proficient outline technique for E-shaped Microstrip patch antenna using Artificial Neural network has been proposed. This shape will give wide data transmission to different applications like Remote detecting, Portable radio, Satellite correspondence, and so on. This antenna has surpassed the bandwidth of UWD necessity which is from 3.1 Ghz to 10.6 Ghz. The different kinds of artificial Neural Systems have been utilized namely Feed forward back propagation, Layer recurrent network in order to provide a comparative overview. The results for the designing of E-shaped Microstrip Antenna obtained from the Artificial Neural Networks are compared with the results obtained from the simulating software, here CST and both the results show good agreement.

***Index Terms*—Artificial Neural Networks (ANN), Computer Simulation Technology (CST).**

I.INTRODUCTION

Artificial neural networks are data handling frameworks with their configuration propelled by the investigations of the capacity of the human cerebrum to gain from perceptions and to sum up by reflection. As exceedingly nonlinear structures, ANNs can precisely show any subjective nonlinear input–output connections between various information sets giving an effective other option to traditional techniques, for example, numerical displaying strategies, which could be computationally costly, or investigative techniques, which could be hard to get for new gadgets or exact models, whose reach and exactness could be limited[1]. ANN model can be gained from: full-wave electromagnetic test systems, material science based models, or estimations.

Artificial Neural Networks (ANNs) are a group of models roused by natural neural networks(the focal sensory systems of creatures, specifically the cerebrum) and are utilized to evaluate or estimated capacities that can rely on upon an extensive number of inputs and are by and large unknown[2]. ANNs are for the most part introduced as frameworks of interconnected "neurons" which trade messages between each other. The associations have numeric weights that can be tuned in view of experience, making neural nets versatile to inputs and equipped for learning. It includes three layers namely input, hidden and output layer. These layers are associated through weights which adjust as per inputs[3]. This element of ANNs make them more dependable and proficient when contrasted with other reproduction programming projects as it doesn't chip away at ON and OFF premise however gains from given inputs and targets and later on when given new inputs it gives results with its own particular rationale which makes it think in a way like organic mind.

Microstrip patch antennas are generally utilized as a part of remote correspondence due to their conformal and planar structure, smallness, low-profile, order with high transmission productivity, light weight, low profile, minimal effort and simplicity of mix with microwave circuit.[6]

Various papers show how ANNs can be utilized proficiently as a part of examining and combining different microwave circuits. This paper is likewise an endeavor to showcase that ANNs are computationally a great deal more productive than EM simulators once they are prepared with solid taking in information acquired from a fine model by EM simulation. The ANNs can be utilized for productive and precise streamlining and outline inside the scope of training[5]. ANN gives quick and precise models to microwave displaying, reproduction and improvement. With their versatile conduct ANNs turn into a best choice if there should arise an occurrence of planning and streamlining the patch antenna.

II.DATA DICTIONARY

For the designing of microstrip patch antennas different kinds of simulation software can be used but here we have used CST software for collecting data for the training and validation of proposed ANN model. As the performance of ANN majorly depends on the training, validation and testing, the network is rigorously trained in order to improve its performance. Hence, the collection of data is the first step in the designing process. The data collected should be in ample amount so that the ANN is properly trained, validated and tested. The reason behind using large amount of data is that many a times the ANN doesn't learn properly and it don't draw the logic properly as a result the outputs obtained will not be much accurate. The data dictionary is built by designing the circular antenna in the above mentioned software and collecting the outputs. Here we collected nearly 80 different values from the CST software and used them for ANN training, validating and testing.

III.ANTENNA DESIGN

The Ultra Wideband antennas covers the frequency range from 3.1GHZ to 10.6GHZ[6]. The configuration methodology

starts with determining the length, width and the sort of dielectric substance for the given working frequency as appeared in stream graph Fig.1 Then utilizing the estimations got above reproduction has been setup for the essential rectangular microstrip antenna and the parameters are upgraded for the best impedance coordinating. Parallel spaces which takes after the state of E is outlined and joined together; this increases the gain of antenna.

The main E shaped patch has Wa x La dimension .The antenna is fed by a SMA connector positioned at the center arm. The center of probe is positioned at (Wc/2,Lf). The width and length of the microstrip antenna are determine as follows:

Where vo is the free-space velocity of light

$$W = \frac{1}{2 f_r \sqrt{\mu_0 \varepsilon_0}} \sqrt{\frac{2}{\varepsilon_r + 1}} = \frac{v_0}{2 f_r} \sqrt{\frac{2}{\varepsilon_r + 1}} \quad (1)$$

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \left[1 + 12 \frac{h}{W} \right]^{-1/2} \quad (2)$$

Where the dimensions of the patch along its length have been extended on each end by a distance *ΔL*, which is a function of the effective dielectric constant εreff and the width to height ratio (*W/h*), and the normalized extension of the length; is

$$\Delta L = 0.412 \; h \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad (3)$$

The actual length of the patch (L) can be determine as

$$L = \frac{1}{2 f_r \sqrt{\varepsilon_{reff}} \sqrt{\mu_0 \varepsilon_0}} - 2\Delta L \quad (4)$$

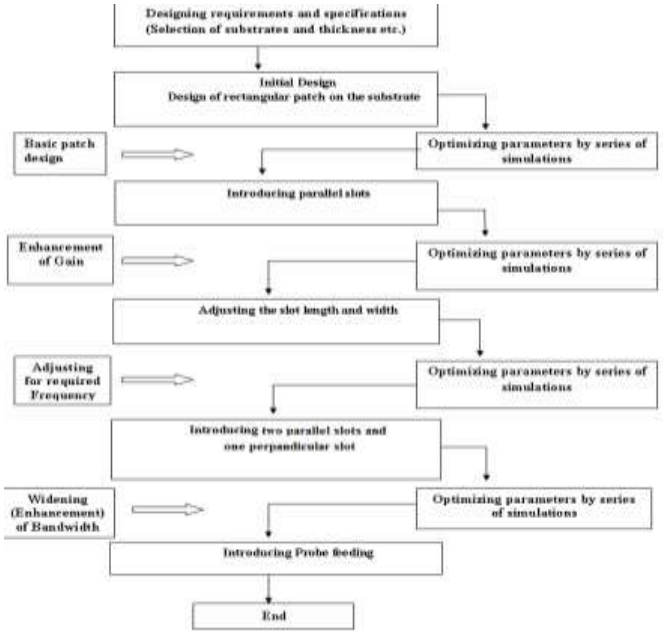

Fig.1 Flow diagram of designing procedure.

A .Geometry of antenna

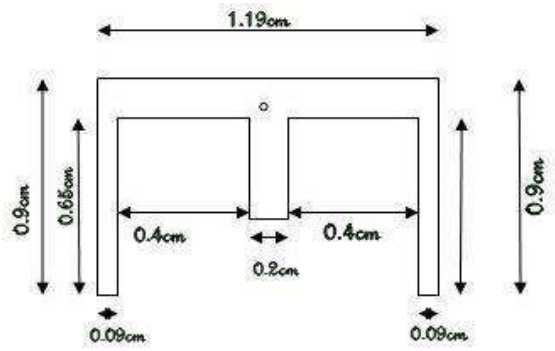

Fig.2 view of antenna

Parallel spaces in this outline are in charge of the excitation of next resonant mode i.e. primary parallel space energize resonant frequency. Openings length (LsA and LsB), space width (S), fundamental space width (WsB) and focus arm (Wc) controls the frequency of the following full mode. Figure 2 demonstrates the cut plane perspective of the antenna. The patch and ground are isolated by shut cell low misfortune air and it advantages to get more extensive transmission capacity and higher gain.

B Artificial Neural Networks

Artificial neural networks (ANN) have been developed as generalizations of mathematical models of biological nervous systems.

The basic processing elements of neural networks are called artificial neurons, or simply neurons or nodes[2]. In a simplified mathematical model of the neuron, the effects of the synapses are represented by connection weights that modulate the effect of the associated input signals, and the nonlinear characteristic exhibited by neurons is represented by a transfer function. The neuron impulse is then computed as the weighted sum of the input signals, transformed by the transfer function. The learning capability of an artificial neuron is achieved by adjusting the weights in accordance to the chosen learning algorithm.

The basic architecture consists of three types of neuron layers: input, hidden, and output layers. In feed-forward networks, the signal flow is from input to output units, strictly in a feed forward direction.

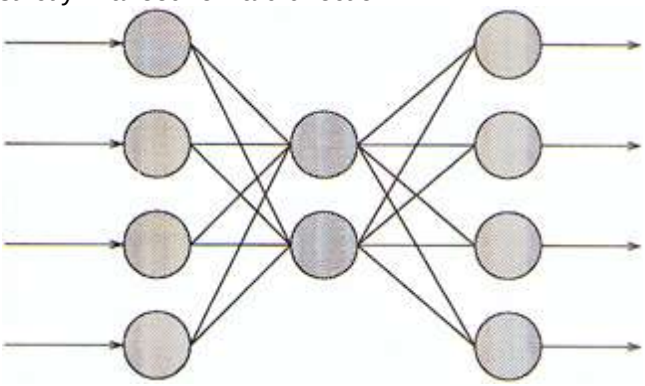

Fig.3 The multi layered perceptron

Training continues on the training set until the error function reaches a certain minimum. If the minimum is set too high, the network might not be able to correctly classify a pattern. But if the minimum is set too low, the network will have difficulties in classifying noisy patterns.

Following are the tables showing the comparison of CST software outputs and ANN outputs. The last column in every table shows the square error.
The square error is obtained by squaring the error calculated by using the relation-

$$Error = Simulated\ output - ANN\ output$$

Table 1 Comparison of directivity when calculated using CST software and FFBP ANN

Length of antenna in mm	Directivity of antenna in CST software	Directivity of antenna calculated using ANN(FFBP)	Square error
50	6.08	6.0124	0.067637
47.5	6.04	6.0395	0.00049484
47	6.05	6.0998	0.00022384
46	6.11	6.2015	0.0052006
45.5	6.1	6.2248	0.015466
45	6.10	6.2545	0.0071128
44.5	6.14	6.3029	0.011523
44	6.17	7.7685	0.0097941
42.5	6.23	7.0767	0.02439

Table 2 Comparison of directivity calculated using CST software and Layer Recurrent ANN

Length of antenna in mm	Directivity of antenna in CST software	Directivity of antenna calculated using(ANN) layer recurrent	Square error
50	6.08	6.0423	0.027689
47.5	6.04	6.0647	0.035321
47	6.05	6.0675	0.032461
46	6.11	6.1171	0.11293
45.5	6.1	6.1626	0.10738
45	6.10	6.4319	0.11809
44.5	6.14	7.4367	0.7329
44	6.17	7.4662	0.46376
42.5	6.23	7.2073	0.012694

These tables show that both the networks show good agreement with the results of simulating software.

IV.CONCLUSION

An effective configuration methodology for E-shaped microstrip patch antenna for FR4 substrate in view of ANN has been talked about here. In the analysis network, one can acquire parameters (directivity) of antenna by utilizing length as inputs. The major advantage of ANN model is that, after proper training, a neural network completely bypasses the repeated use of complex iterative processes for the new design presented to it. This ANN model is suitable for Computer Aided Designing applications.

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