Microstrip Antenna Parameters Optimization

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ABSTRACT:
The genetic algorithm is one of the most powerful optimization algorithms in electromagnetism. In this paper, we optimized gain of a microstrip patch antenna using genetic algorithms. The cavity method used for the analysis of this antenna. The simulation results were compared with results obtained in previous work. The resulting gave gain more than the previous one.

KEYWORDS: genetic optimization, microstrip antennas, gain, input impedance, resonant frequency

1. INTRODUCTION

Microstrip antenna is a radiation patch that placed in a dielectric layer. A patch antenna is a narrowband, wide-beam antenna made-up by design the antenna element model in metal trace linked to an insulating dielectric substrate. This antenna is typicallyused in microwave frequencies [1].
Because such antennas have a very low shape, are automatically rugged and can be bent to match to the curving coat of a vehicle, or are incorporated into mobile radio communications devices [1, 2].
The rapid expansion of printed antennas technology (microstrip) is because good properties of this type of antenna.
Genetic algorithms (GAs) are a great optimization method that has been exposed to be of use in a broad region of electromagnetic for example antennas, antenna arrays, and radar systems [1-4].
GA is adaptive heuristic look for algorithm based on the evolutionary ideas of natural selection and genetics [5]. As such they embody a clever use of a random search used to solve optimization problems. Although randomized, GAs are by no means chance, in its place they use historical information to direct the search into the area of better performance within the search space. The basic methods of the GAs are designed to simulate processes in natural systems essential for development, ones [6 -9].
Microstrip patch antennas using GA is shown in the literature and GA optimization has been employed by researchers to design multiband microstrip patch antennas.

2. MICROSTRIP ANTENNA

microstrip patch antenna is a Rectangular patch that from of high and low are covered with electrical wall and from of right and left are covered with magnetic walls. In Below figure is displayed a microstrip antenna.

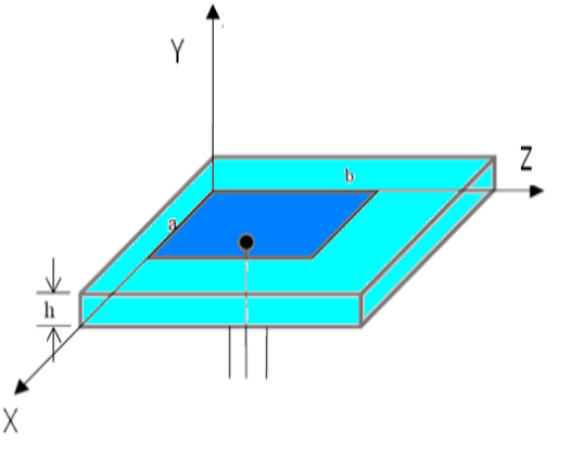

Fig. 1. A microstrip patch antenna

The electric field (E) inside antenna is as follows:

$$E_Z = E_0 Cos\frac{m\pi x}{a} Cos\frac{n\pi y}{b} \quad (1)$$

a and b, the rectangular patch in the x and y dimensions, respectively. Because we have the magnetic walls, therefore field is zero on them.
So we have:

$$\frac{\delta E_z}{\delta x} = 0 \quad (2)$$

$$at \;\; y = 0, \;\; b$$

$$\frac{\delta E_z}{\delta y} = 0 \quad (3)$$

$$at \;\; x = 0, \;\; a$$

The directivity in the antenna in mode (0 and 1), comes to the following equation.

$$D = \frac{2h^2 E_0^2 b'^2 K_0^2}{P_r \pi \eta_0} \quad (4)$$

$$\frac{\delta E_z}{\delta y} = 0 \;\; at \;\; x = 0, \;\; a \quad (5)$$

In this formula h is dielectric layer thickness and other parameters achieved according to the following

equation.

$$k_0 = {2\pi}/{\lambda_0} \quad (6)$$

$$\mathrm{b}' = b + h \quad (7)$$

$$\eta_0 = 120\pi\Omega \quad (8)$$

$$\eta = \frac{P_r}{P_T} \quad (9)$$

The radiation Power and total dielectric losses power, including radiation and guidance.
Gain respect by using from the cavity model comes to the following equation:

$$G = \frac{P_r}{P_T} \quad (10)$$

$$D = \frac{2h^2 E_0^2 b'^2 K_0^2}{P_T \pi \eta_0}$$

3. APPLICATION OF GENETIC ALGORITHMS IN MICROSTRIP ANTENNA

Step 1: Create chromosome

Determine the number of chromosomes, generation and mutation rate and crossover rate value.
To optimize microstrip patch antenna choice according to the value function, four variables a, b that are length and width of patch, respectively and h Dielectric thickness and ε is constant dielectric that are as 4 gene in there.
For each of these variables have limitations.
a and b are between 7mm to 15mm, ε between 2.2 to 4.8 and the value of h varies between 1mm to 3mm.
These four variables formed a chromosome. So initially chromosomes created randomly, number the size of generation given the data values. Then the value function obtained for the values of calculation variables. The value function converted to dB and arranged in descending order to know the maximum amount for which each has obtained chromosome and insert it in the next generation.

Step 2: the penalty

If the variables are not in our area in each generation by using of means penalty choose of a fine that the value of it is low and likely to reduce in the next generation.

Step 3: crossover

To create a new generation, the 0.3 of the previous generation selected randomly, each of time choose two of the chromosome as two parents and merged together and then enter the number of children a generation.

Step 4: Mutation

Randomly, 0.04 of prior generation select to mutant. To do this, after choose chromosome, one of its genes multiplied randomly into a number between 0.6 to 1.3. It should be noted that at this stage, genes were in range of that initially looked for them.

Step 5: Complete the new generation

To complete the new generation, in addition to enter the children and has mutated into a best chromosome of prior generation and rest enter at random from the previous generation, the new generation of fully treated this way.

4. RESULTS

With using simulation, the gain of microstrip antenna obtained. The maximum amount of gain is 7.1271 that were obtained for the following variables:

$$\varepsilon = 2.2725, \quad a = 14.5985, b = 14.8273, \quad h = 1.9251$$

These amounts were performed to a total of 400 chromosomes and 400 generation.
The gain of the antenna has been improved with respect to the previous value of the 6.29 in reference [2]. In the below figure, the value of gain displayed for the number of generations.

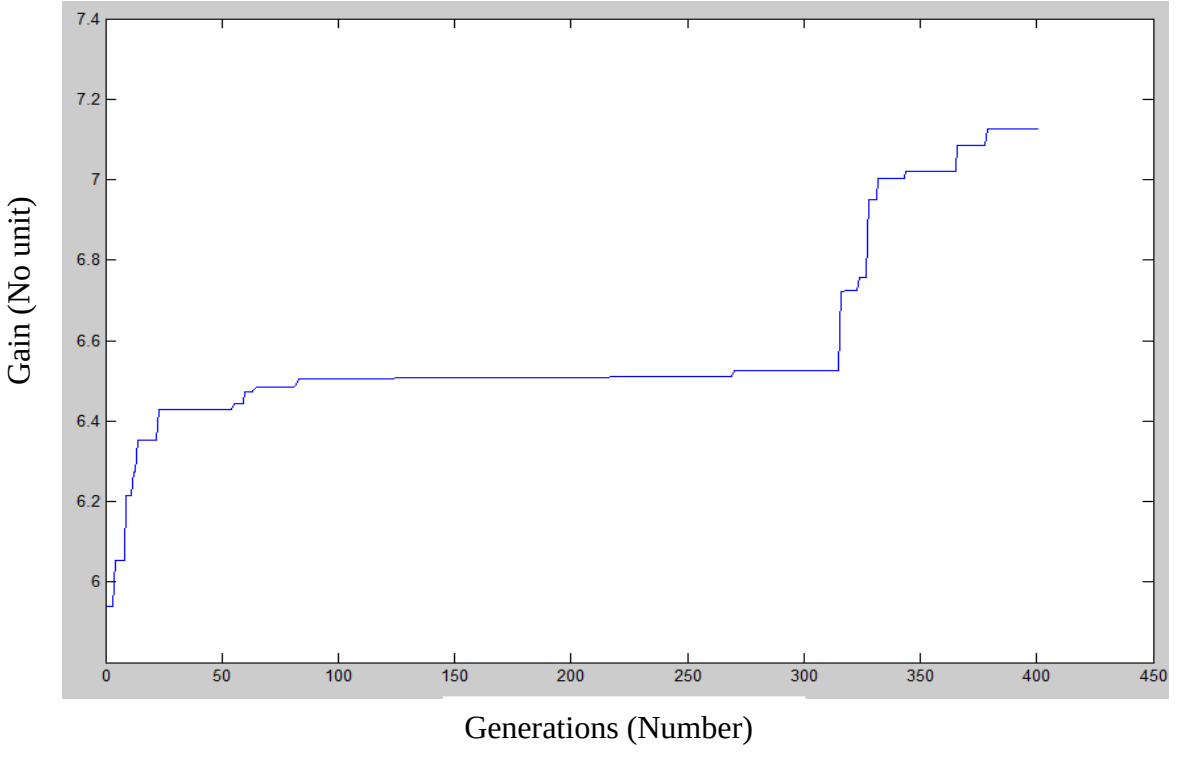

Fig. 2. Changes of gain obtained in rectangular microstrip antenna.

4. CONCLUSION

Using of genetic algorithm can increased to gain a microstrip antenna. Also, if a layer of dielectric put on top of the antenna. This result will better value. The MATLAB software is used to implement a genetic algorithm.

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