International Journal of Engineering Applied Sciences and Technology, 2016
Vol. 2, Issue 2, ISSN No. 2455-2143, Pages 30-33
Published Online December-January 2016 in IJEAST (http://www.ijeast.com)

MICRO STRIP PATCH ANTENNA OPTIMIZATION USING GENETIC ALGORITHM

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***Abstract*: - This paper presents a new formula for the miniaturization of rectangular microstrip patch antenna base on genetic algorithms. The shape of a typical rectangular patch is modified in order to decrease its size keeping the resonant frequency constant. In this paper, a novel shape antenna is designed with slits, rings, and coaxial probe feeding. The Patch antenna is optimized for its design parameter as length and width. Optimized results will give high efficiency to the performance of the antenna.**

***Keywords**: Patch antenna, Genetic Algorithm, Return Loss, and Directivity.*

I. INTRODUCTION

The new developments of the wireless communication area have a lot of investigating to do with the microstrip patch antenna. The advantage of these antennas, they are small in size, low-priced for built-up and light in weight, so they can move easily to any other place. As a result, it enables to introduce small mobile handset as a replacement of heavy model [1-4]. In this proposed paper, genetic algorithm is used for size reduction. Genetic algorithm optimization is a great method for optimized patch antenna parameter. A Genetic algorithm is a tough, stochastic-based search method, which can handle the general feature of electromagnetic optimization problems that are not eagerly handled by other conventional optimization method [5-6].

The GA method is based on the Darwinian principle of survival of the fittest. GA optimizer procedure is shown in fig. 1 it begins by produce arbitrarily scattered primary population. Later than the primary population is formed and fitness value assign to each member of the population, a reproductive circle, consisting of a collection, crossover, and mutation operator, are performed until an adequate amount of new individuals are generated to fill new production. When new generation has been entirely filled, it replaces the older generation and, if the termination condition has not been met, a new round of selection, crossover, and mutation begins [7]. In this paper, genetic algorithm is used to design patch geometry for WLAN (2.4 GHz) application. A novel shape of patch antenna is introducing. The study of patch antenna is done by HFSS (high frequency structure simulator) which is finite element method based software and provides highly accurate results [8].

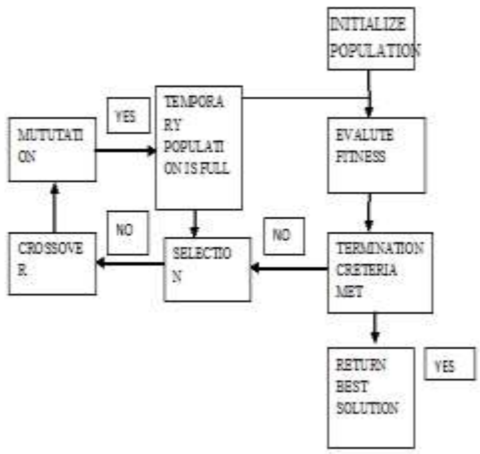

Fig 1 Genetic algorithm flow chart

II. ANTEENA GEOMETRY AND OPTIMIZATION PROCEDURE

The antenna uses a substrate of dielectric constant 4.4 and substrate thickness 1.6mm. The patch was designed on a rectangular area of 28*33mm (L_a* W_a). In this design two rectangular slits and three

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circular slots with the dimension of 26*1.8mm (L_a* W_a) and 22*4.5mm (L_b* W_b) and the radius of the circular slot is R_1, R_2, and R_3 is 4mm, 4mm and 3.3mm. A rectangular patch of these dimensions resonates at the center frequency of the WLAN frequency band 2.4GHz. The feed position is placed centered in the patch. The rectangular patch antenna with its dimension and software image is shown in fig.2 and 3.

The ANSYS HFSS software is used to analyze the antenna. By the analysis of an antenna, the return loss is 14.21 and VSWR is being 3.08 which are shown in Fig. 4 and 5. Fig. 6 and 7 shows the gain and directivity of an antenna which is 1.08 and 3.38. In order to search better result with small size, we applied genetic algorithm optimization. This is as well done with the help of optometric functionalities of the ANSYS HFSS.

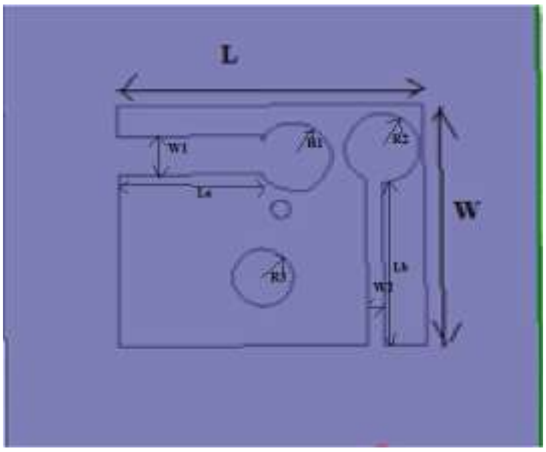

Fig: 2 Image of patch antenna

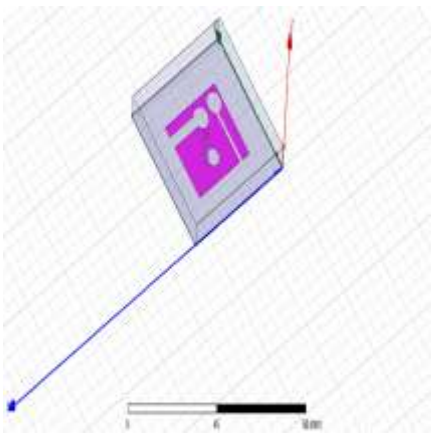

Fig: 3 Antenna design in software

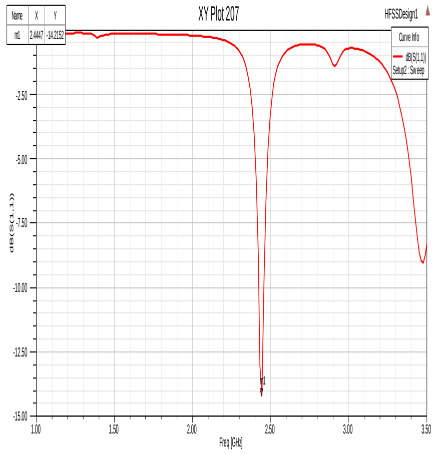

Fig: 4 Return Loss Of Antenna

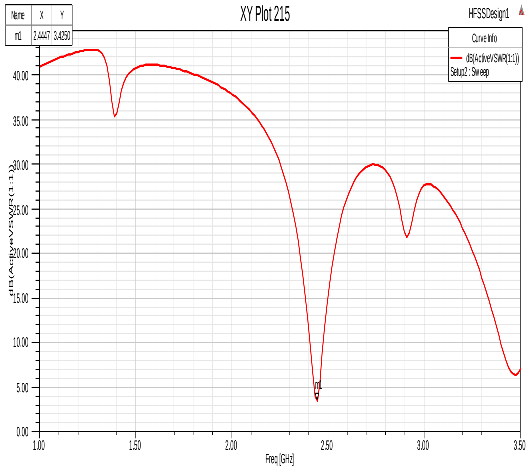

Fig: 5 VSWR Of Antenna

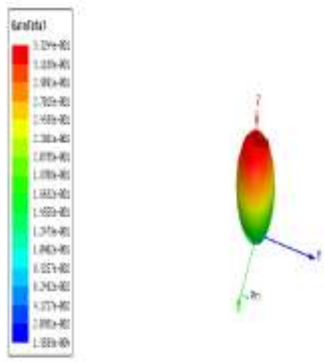

Fig: 6 Gain Of Antenna

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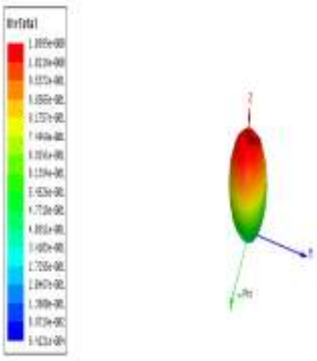

Fig: 7 Directivity of Antenna

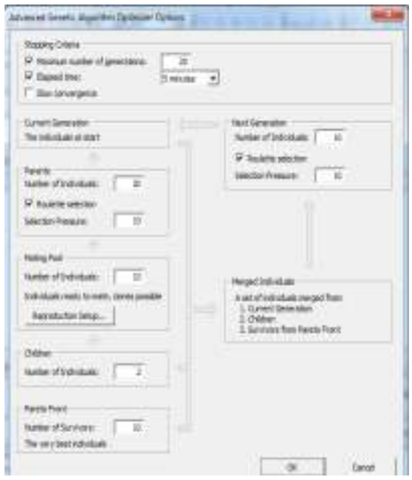

Fig: 8 genetic window in ANSYS HFSS

A.Genetic Algorithm

Genetic algorithm optimization (GAO) is an influential optimization technique use in patch antenna design [5]. It is based on the method similar to natural selection. At every stage, GA selects at random a set of individual from the existing population as the parents and use them to produce the next generation children. This is frequent until an optimum solution is met [6]. For the proposed antenna design the parameters for the algorithm proceed with the help of the following inputs:

Maximum no. Of generation- 20
mututation rate-10
Random search- 20
population size-10
Crossover rate-10

B.Optimization Result

Fig.8 shows the genetic window of ANSYS HFSS software where these parameters are applied. The optimal parameter obtained by the GA is given as the dimension for the patch length and width are 25*20mm and the rectangular slits are 18*1.8mm and 20*2.5mm. The radius of the circular slot is 2mm and 2.5mm as shown in the fig.9 the antenna became 70% smaller from the un-optimized antenna. With these values of an optimal parameter of an antenna, the result is shown in figure 10, 11, 12 and 13. The return loss shown in fig.10 of optimized patch is 25.16 db and the VSWR shown in fig. 11 is 1.1. This is a good result compared to un-optimized patch antenna. The gain and directivity are also shown in fig. 12 and 13 which is 9.67 and 7.5.

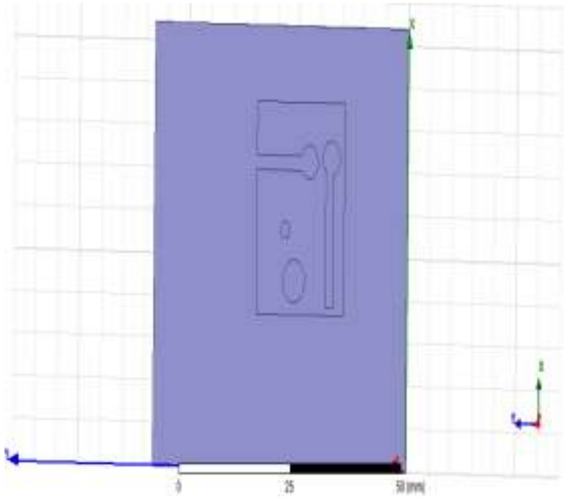

Fig: 9 Antenna design after optimization

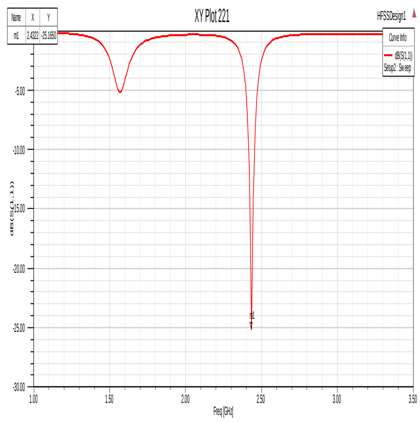

Fig: 10 optimized return loss of antenna

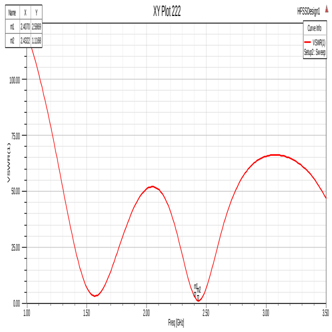

Fig: 11 optimized VSWR of antenna

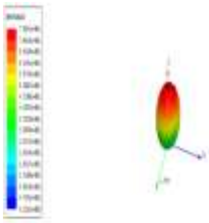

Fig: 12 optimized gain of antenna

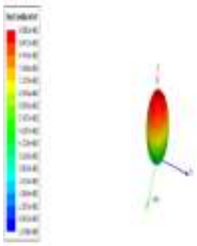

Fig: 13 optimized directivity of antenna

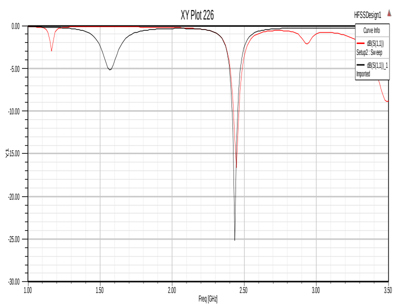

Fig: 14 comparison of return loss

III. CONCLUSION

The length and width of coaxial probe feed patch antenna were optimized using a genetic algorithm technique in ANSYS HFSS software. The use of this GA has improved the antenna performance and minimizes70% of its size. When we compared the result of optimized antenna with un-optimized antenna (return loss comparison is shown in fig. 14) we see that the performance of optimized antenna is 54% better. In the future, we can optimize the antenna with more performance parameter as gain and bandwidth. Also, we can check the performance for the different type of feeding method and try to make it for multiband.

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