Review on Various Optimization Techniques for Microstrip Patch Antenna

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***Abstract*— Lately Microstrip Patch Antenna(MPA) is being used and studied widely in the past decades. The antenna consists of a metallic patch printed on a dielectric substrate over a ground plane, it offers many advantages that includes ease of design and fabrication, planar structure and ease of integration with circuit elements. It also has advantages due to it's light weight, small size and low cost. The major drawback in MPA is the narrow bandwidth that makes them unsuitable for the present day scenario of using wireless communication technologies. Although extensive studies in the last decadeson antenna performance improvement has developed various techniques to enhance the bandwidth. The microstrip antennas are widely used in military, industrial and commercial sectors.**

***Keywords* - Microstrip Patch antenna, Genetic Algorithm (GA), Optimization.**

I. INTRODUCTION

Antenna is used as a part of a transmitting or receiving system that is designed to radiate or receive electromagnetic waves. Micro-strip antennas(MSA) are one of the most popular types of printed antennas. Nowadays wireless communication system cannot be thought without these antennas. MSA is one of the critical components inany wireless communication system since they not only eliminate feed radiation but are also compact, robust ,simple to construct and implement . They are also capable of giving a good performance under various circumstances, including those involving tight frequency selectivity, customized radiation pattern and lowloss conditions.

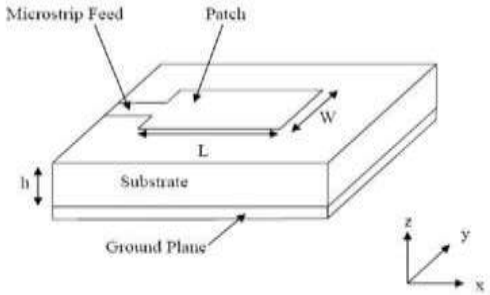

Fig. 1: Front view of Microstrip Patch antenna

However, narrow bandwidth, low gain and efficiency often limit their use. Therefore, the designing of these antennas in accordance to various scenarios is a difficult task, thus we usegeneticalgorithmsforthesame.

Genetic Algorithms(GAs) that belong to the larger part of evolutionary algorithms are adaptive heuristic search algorithms . These algorithms are based on the ideas of natural selection and genetics. They use the input data from the user to learn the required solution domain such that the algorithm itself learns the user and what they require to better the performance of the system. They are commonly used to generate high-quality solutions for large and complex data sets. Genetic algorithms are very different from most of traditional optimization methods since they work with a coding variable. These algorithms need design space to be converted into a genetic space. The main advantage of coding in GA is that, it can convert a continuous search space to a discrete one. GA uses multiple point approach in contrast to the traditional optimization of single point method for a given population of point si.e. it can exercise on a number of single point designs simultaneously. Basically a GA uses a set of randomized operator which improve the search space in adaptive manner. During a GA optimization, encoding of parameters of each individual of population is done to convert into string of bits (chromosomes). The first group of individuals which is termed as generations is created randomly. The fitness of each member of group (individual) is determined by the cost function. The process of mating finds out new generation. The more fit individuals are selected and given morechances of reproducing. Crossover and mutation both of these used to allow global exploration of cost function. The best individual may be send unchanged to the next generation. This repeating process creates successive generations until a stop criterion is reached. In other words, it's survival of the fittest.

Fig. 2: Flow chart of genetic algorithm optimization

Recently, several methods have been used to optimize patch antennas such as using a dielectric substrate of high permittivity, and various existing optimization algorithms such as particle swarm optimization (PSO) and genetic lgorithm (GA).The latter is one of the global optimized algorithms that have been used by the designers for optimization of antennas. It is a powerful, stochastic based search method, which can handle optimization problems that cannot be handled by conventional methods. One of the concepts of genetic algorithm is to divide any regular square microstrip patch antenna to a grid of symmetrical squares and then use genetic algorithms to selectively to remove smaller metallic grid squares from the patch, and then, novel non-intuitive shapes can be formed. This method is also used to make dual-band antennas because of several current paths on the patch, wide-band antennas, and longer meandering current paths on the patch which leads to miniature performanceof patch antennas. Genetic algorithm can also be used to design the patch geometry, substrate thickness, etc in order to optimize gain and bandwidth of the antenna. The design ofa microstrip patch antenna can be implemented using FR4 substrate. FR stands for flame retardant and the material resembles with the standard UL94V-0. The designation FR-4 was developed by the NEMA in 1968.FR-4 glass epoxy is a popular and versatile high-pressure thermoset plastic laminate grade with good strength to weight ratios. With very less water absorption, FR-4 is mostly used as an electrical insulator possessing considerable mechanical strength. The material is famous to retain its high mechanical values and electrical insulating qualities in both of the dry and humid conditions. These attributes along with good fabrication characteristics, provides utility to these grade for a wide variety of electrical and mechanicalapplications.

2. REVIEW ON PREVIOUS WORK

Raj Gaurav Mishra,Ranjan Mishra"Analysisof themicrostrip patch antennadesigned using genetic algorithm based optimization for wideband applications".[1] This paper deals with designing of microstrip patch antenna using Genetic Algorithm. It is used to give return loss value of -60 dB at a resonating frequency of 5.16 GHz and a bandwidth range of 7.16GHz .Genetic Algorithm consists of parameters like string of bits that is also called as chromosomes, population size and total number of generations are used to optimize the antenna geometrical parameters. Design checks are used to validate the chromosomes i.e string of bits.S_{11} parameter is calculated and then sent back to primary function directly(MATLAB), it can be used for calculation by fitness function. The cost function is given by:

$$Cost = [-(12*BW)+S_{11(Res)}]$$

The fabrication is done using FR4 substrate as it is inexpensive and easier in fabrication.

Priyanka Jain, Vikas Maheshwari, Vandana Vikas Thakre, "Micro Strip Patch Antenna Optimization Using Genetic Algorithm".[2] This paper deals with optimization of bandwidth and gain of a microstrip patch antenna . This can be achieved by using high dielectric constant substrate by cutting holes and slots, by increasing the thickness h of the parallel plate transmission line the bandwidth can be increased. The antenna performance with the changes in the shape and it's placement in the patch can be varied by the slot. It also mentions that when the length of the slot is increased the bandwidth can be increased but then there is decrease in the resonance frequency. The affected region of the frequency is also mentioned i.e higher frequency with -10 dB return loss is affected whereas the lower frequency of -10dB return loss is not affected .

The antenna gain can be improved by placing three triangular slots in ground below equilateral triangular patch at proper locations.

Susmit Bhattacharya and Souti Chattopadhyay,"Optimization of Inset-fed Microstrip Patch Antenna using Genetic Algorithm";[3] This paper deals with physical dimension optimization of inset-fed microstrip patch antenna using Genetic Algorithm. The three components on which optimization of inset-fed patch antenna depends primarily are length, width and inset depth. The population size was taken as 50.As the population size is high there is wastage of computational resources, which includes more complexity of selection procedure and unwanted redundancy, where as the lower population gives the accuracy and performance. The fitness function is given as:

$$Fitness(L,W) = abs\ (2.4*10^9 - f_0)$$

L and W are length and width of the microstrip patch anf f_o is the resonant frequency.

Chandran, P. P, &Viswasam, S (2014). Gain and Bandwidth Optimization of Microstrip Patch Antenna;[4] This paper deals with the optimization of design parameters of microstrip patch antenna to provide high efficiency. The advantages of microstrip patch antenna is that they are small in size, low price, light in weight and can be moved from one place to another.At first, the primary population is created and after which a fitness function is given to all the members of the population, followed by crossover and mutation.The procedure continues until exact amount of new population is formed. New population is obtained after many generations and the results is sent to HFSS for analyzing the parameters and providing the exact results for the process. The parameters like gain and directivity can be optimized.

Jayasinghe, J.M.J.W., & Uduwawala, D.N. (2010). Design of patch antennas using genetic algorithm optimization;[5] The paper deals with antenna geometry and procedure of Genetic Algorithm optimization. The patch is divided into many small parts for the optimum radiation which are called as the square cells. Either Conducting or non-conducting properties are present for each and every cell which are symmetric in nature

. Only two possible vales are present for each cell where binary code is used. Chromosomes represent the full fragmented patch, when other parameters are added in the design, the corresponding are added to it subsequently.

III. CONCLUSION

The proposed work presents the simulation and Optimization of microstrip patch antenna designed using HFSS and Genetic Algorithm. The motivation of this work is to improve the antenna's return loss S_{11} and radiation Efficiency. The proposed papers gives idea about the size and radiation pattern. Based on this research, we can design and optimize for wide-band applications.

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