INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

(Volume1, Issue 2)

Design of Patch Antenna Using Optimization

Vipasha Sharma
Vipashasharma1992@gmail.com

Deepika Chouhan
deepikachauhan1992.bu@gmail.com

Abstract— Particle swarm optimization is a popular optimization algorithm used for design of microstrip patch antenna. This paper presents design of probe fed rectangular microstrip patch antenna for frequency ranges from 3-8GHz using particle swarm optimization. A substrate with dielectric constant of 2.4 and height 1.578mm has been used for the design of microstrip patch antenna. PSO has been used to optimize the parameters like patch length, width and feed position using Sonnet13.52

I. INTRODUCTION

Microstrip patch antenna has gain attention for wireless communication applications due to its low profile, low weight, low cost and small size [1]. Microstrip patch antenna is preferred for wireless communication applications. Microstrip patch antenna consists of a conducting rectangular patch of width W and length L on one side of dielectric substrate of thickness h and dielectric constant. Most popular methods to feed the microstrip patch antenna are microstrip line feed, coaxial probe feed, aperture coupled feed and proximity coupled feed. Top view of rectangular microstrip patch antenna using coaxial probe feed is shown in figure1. Probe fed [2] microstrip patch antenna shown in Fig2.uses a coaxial connector soldered to the patch.

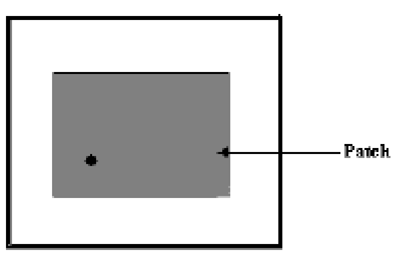

Fig1.Top view of probe fed rectangular microstrip patch antenna

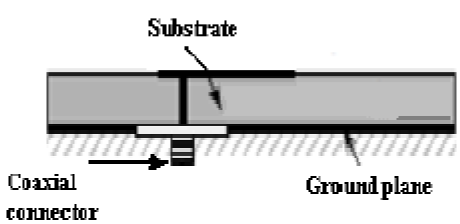

Fig.2 Side view of coaxial probe fed rectangular microstrip patch antenna [2]

In 1995, particle-swarm optimization (PSO) was presented by James Kennedy and Russell Eberhart. PSO is based on movement and intelligence of swarm of bees or flock of birds [3] [4].A swarm of bees whenever fly in the field always try to find the location with abundance of flowers. Bee starts from a random location and a random velocity. Each bee has a change of velocity and position at each step. Change of Velocity of the particle is given as:

$$v_n = wv_n + c_1 rand\ ()\left(p_n^{bp} - x_n\right) + c_2 rand\ ()\left(g^{bp} - x_n\right)$$

Wnis the coordinate of the particle along the Nth dimension. ,p and g are the personal best position and global best position respectively. The personal position and value are related to individual particles. The global best position and value are equal to all individuals. ,c1 and c2 are scaling factors and rand ( ) is uniformly distributed random number in the range 0 to 1. w is inertial weight and is used for controlling the convergence. Determine next position according to the equation given below:

$$x_n = x_n + v_n * \Delta t$$

Tis time step whose value is chosen to be 1 .

III. Results And Discussions

In this paper, length, width and probe offset of the patch have been optimized to resonate the microstrip patch antenna at the frequency ranging from 3-8GHz .Taking the following equations Resonant frequency of the rectangular microstrip patch is given by [6]:

$$f_r = \frac{c}{2L\sqrt{(\varepsilon_{reff})}} \qquad (1)$$

Here c is velocity of light.
Equation for ε_{reff} is given as below:

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(1 + \frac{12h}{W}\right)^{-0.5} \qquad (2)$$

The resonant length of patch is not exactly equal to the physical length due to the fringing fields on the sides of patch. Effective length L_{eff} of patch is longer than its physical length and is given as:

$$L_{eff} = (L + 2\Delta L) \qquad (3)$$

Increase in patch length (ΔL) is given as:

$$\Delta L = 0.412\frac{h(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)} \qquad (4)$$

Considering the fringing fields on sides of the patch, resonant frequency of patch is given as [6]:

$$f_r = \frac{c}{2L_{eff}\sqrt{\varepsilon_{reff}}} \qquad (5)$$

Equation (6) gives the width of microstrip patch.

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \qquad (6)$$

Design parameters chosen for microstrip patch antenna are

1. Center frequency ranges from 3-8GHz
2. The substrate material is Duroid
3. Dielectric constant of the material is 2.4 4. Substrate thickness is 1.578mm

TABLE-1 Optimum Patch length, Width, Feed position and Return loss for frequency ranges from 3-8 GHz (used for mobile communication systems)

Frequency (in GHz)	Optimized Patch length (in mm)	Optimized Patch width (in mm)	Probe offset (in mm)	Return loss (in dB)
3	30.76	40.97	9.44	-26.8
4	22.75	30.7	6.62	-31.39
5	18.04	24.58	4.83	-25.47
6	14.86	20.49	3.72	-29.3
7	12.81	17.56	2.24	-18.77
8	10.97	15.36	2.37	-21.09

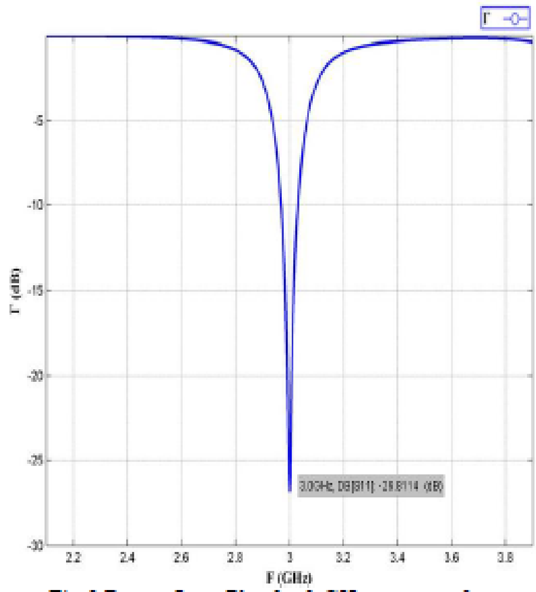

Fig.3 Return Loss Plot for 3 GHz resonant frequency

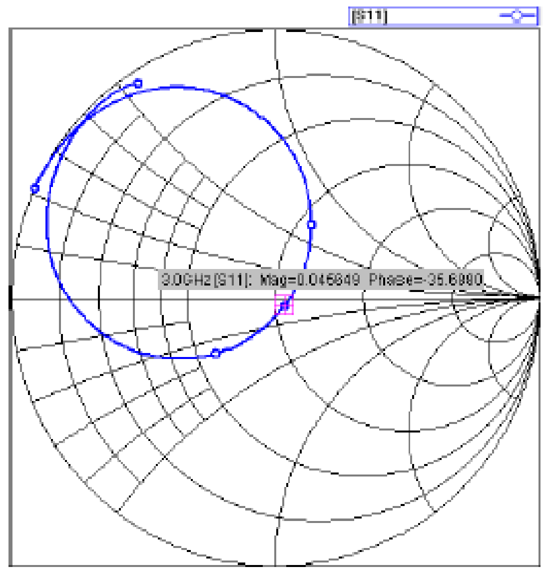

Fig.4 Smith chart of the 3GHz patch antenna

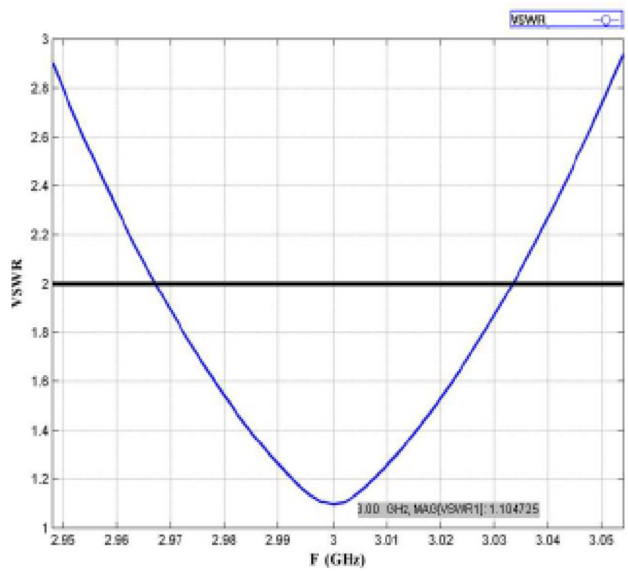

Fig.5 VSWR versus frequency plot of the 3GHz patch antenna

IV. CONCLUSION

It can be concluded that the use of PSO saves time as compared to the design of patch antenna without using optimization algorithm and also PSO restricts the variation from center frequency. Return loss plot showed that microstrip patch antenna resonated exactly at the center frequency with the use of PSO.

References

[1] Constantine. A. Balanis, *Antenna Theory, Analysis and Design*, John Wiley & Sons, New York, 2005

[2] Ramesh Garg, Prakash Bhartia, *Microstrip antenna design handbook*, Artech house, 2001

[3] Jacob Robinson and YahyaRahmat-Samii, "Particle Swarm Optimization in Electromagnetics", *IEEE Transactions on Antennas and Propagation*, vol 52, pp.397-407, 2004

[4] Russell C. Eberhart, Yuhui Shi, "Particle Swarm Optimization: Developments, Applications and Resources",Proceedings Congress on Evolutionary Computation, vol.2,pp.81-84,2001

[5] Malay Gangopadhyaya,Pinaki Mukherjee and Bhaskar Gupta, "Resonant Frequency Optimization of Coaxially Fed rectangular Microstrip Antenna Using Particle Swarm Optimization Algorithm", *Annual IEEE India Conference (INDICON)*,pp.1-3,2010

[6] VidyaSagarChintakindi, Shyam. S.Pattnaik, O.P.Bajpae, Swapna Devil, Sastry V.R.S. Gollapudi, Patra.K.Pradyumna, "Parameters Calculations of Rectangular Microstrip Patch Antenna using Particle Swarm Optimization Technique", *Applied Electromagnetics Conference*, pp.1-4, 2007