MICROSTRIP PATCH ANTENNA ARRAY DESIGN AND SIMULATION

Supriya Jaiswal[1], Haneet Rana[2] , Paurush Bhulania[3]

[1] P G student. Amity School of Engg & Technology, Amity University, Noida , India,
[2,3] Department of Electronics & Communication , Amity School of Engg & Technology , Amity University , Noida , (India)

ABSTRACT

An antenna array is a collection of homogeneous antennas oriented similarly to get greater directivity and gain in a desired direction. This feature can be exploited to increase the gain of an antenna along with other important parameters, miniaturize classical antenna elements, and overcome some of the limitations of small antennas. In this paper a rectangular patch fed with microstrip feed line has been used to increase the bandwidth and multi resonant nature of the antenna array. The numerical study has been done by using Zeland make IE3D electromagnetic simulator.

Keywords: Antenna Array, Antenna Gain, Slotted Microstrip Patch, IE3D Electromagnetic Simulator, Antenna Feed Point

I. INTRODUCTION

The wireless industry is witnessing a volatile emergence today in present era. Today's antenna systems demand versatility and unobtrusiveness. Furthermore, aesthetics in the design of the systems are always important, some applications require the antenna to be as miniaturized as possible. The basic drawbacks of patch antennas are low bandwidth and comparable low gain even though these antennas are compact in size. In this paper we have designed basic patch antenna operating for GSM and WLAN application and its array implementation to enhance the subsequent Bandwidth and Gain and other related parameters such as Directivity, Antenna efficiency etc.

II. MICROSTRIP PATCH ANTENNA

Microstrip patch antennas have a very high antenna quality factor (Q). It represents the losses associated with the antenna where a large Q leads to narrow bandwidth and low efficiency. Q can be reduced by increasing the thickness of the dielectric substrate. But as the thickness increases, an increasing fraction of the total power delivered by the source goes into a surface wave. This surface wave contribution can be counted as an unwanted power loss since it is ultimately scattered at the dielectric bends and causes degradation of the antenna characteristics. Other problems such as lower gain and lower power handling capacity can be overcome by using an array configuration for the elements.

A Micro strip Patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Figure 1. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate.

For a rectangular patch, the length L of the patch is usually $0.3333\lambda o < L < 0.5\ \lambda o$, where λo is the free-space wavelength. The patch is selected to be very thin such that $t << \lambda o$ (where t is the patch thickness). The height h of the dielectric substrate is usually $0.003\ \lambda o \leq h \leq 0.05\ \lambda o$. The dielectric constant of the substrate (εr) is typically in the range $2.2 \leq \varepsilon r \leq 12$. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation. However, such a configuration leads to a larger antenna size. In order to design a compact Micro strip patch antenna, substrates with higher dielectric constants must be used which are less efficient and result in narrower bandwidth.

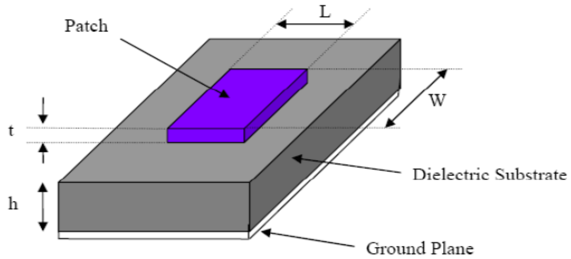


Figure 1: Structure of a Microstrip Patch Antenna

III. MICROSTRIP LINE FEED

In this type of feed technique, a conducting strip is connected directly to the edge of the Microstrip patch as shown in Figure 2. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure.

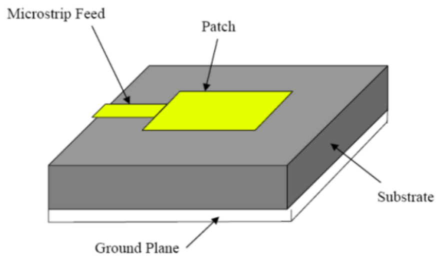


Figure 2: Microstrip Line Feed

The purpose of the inset cut in the patch is to match the impedance of the feed line to the patch without the need for any additional matching element. This is achieved by properly controlling the inset position. Hence this is an easy feeding scheme, since it provides ease of fabrication and simplicity in modeling as well as impedance matching.

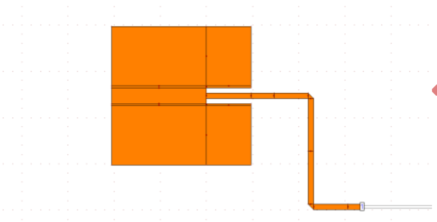
IV. DESIGN SPECIFICATION OF MICROSTRIP FEED SLOTTED PATCH ANTENNA

Before designing the antenna, the first step is to consider the specification of the antenna based on its application. After performing some research, the various parameters are listed in the Table 1, using the specifications we can design an array of microstrip antenna using two, four, eight, sixteen, thirty two basic patches.

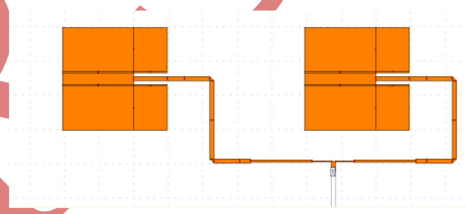
Table 1: Single Patch Antenna Design Specifications

Frequency	1.9 GHz
Substrate	FR4
Dielectric Constant, (εr)	4.7
Loss Tangent	0.019
Substrate Height	1.6 mm

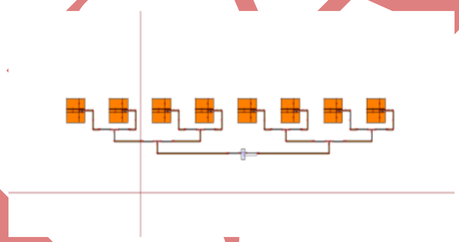
V. DESIGN



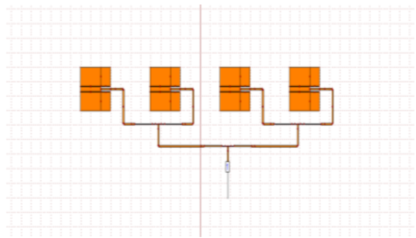
(a) Basic Patch



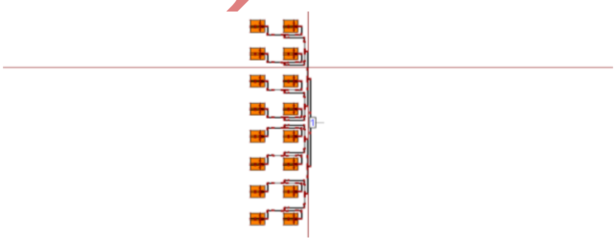
(b) Patch antenna array using two basic patches



(c) Patch antenna array using four basic patches



(d) Patch antenna array using eight basic patches



(e) Patch antenna array using sixteen basic patches

Figure3. (a), (b), (c), (d) and (e) Shows The Basic Antenna & Its Array Implementation

VI. RESULTS

In this paper we show the results by comparing all the three proposed antennas along with array implementation one by one on the basis of Directivity, Gain and Antenna Efficiency. It is quite clear that while array implementation of same antenna the resonance remains invariant ,while other antenna parameters improves for higher order of arrays.

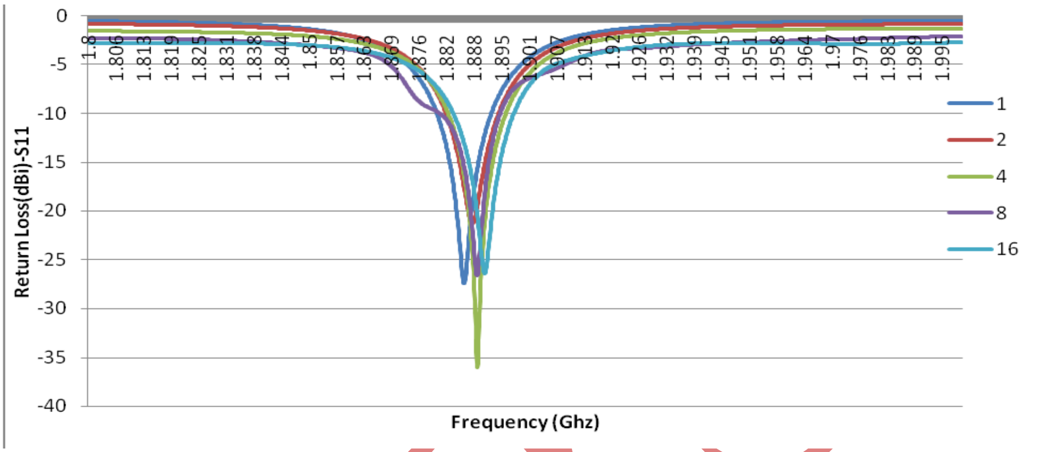


Figure 4: Combined comparative return loss curve

For the figure 5, 6, 7 and 8 single patch is indicated by pink colour, array using two basic patches is indicated by green colour, array using four basic patches is indicated by red colour, array using eight basic patches is indicated by blue colour, and array using sixteen basic patches is indicated by black colour.

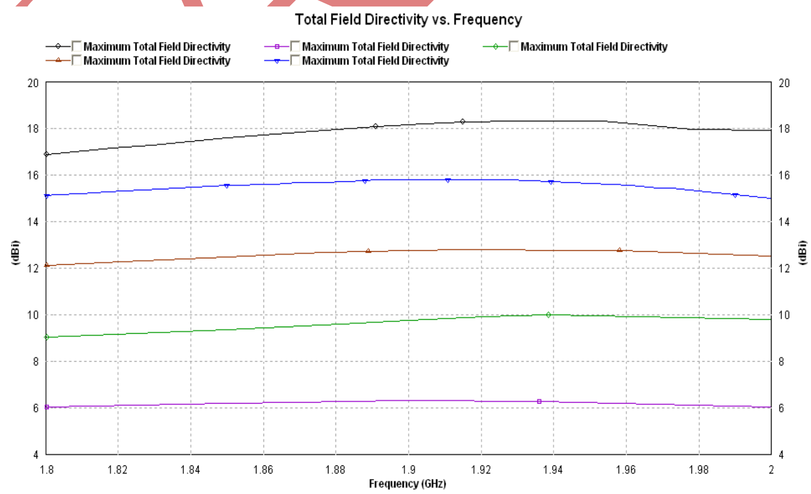


Figure 5. Directivity Vs Frequency Curve

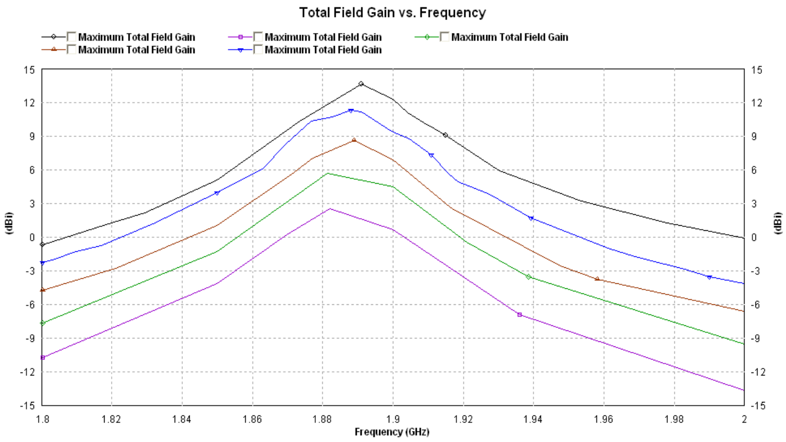


Figure 6. Gain Vs Frequency

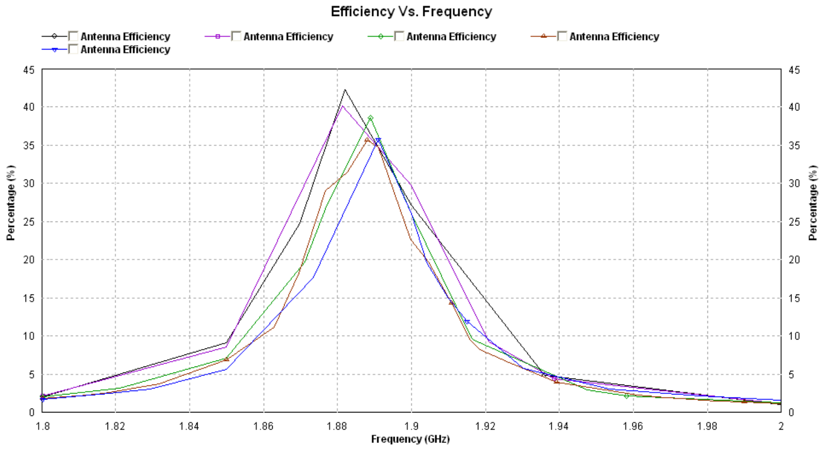


Figure 7. Antenna Efficiency Vs Frequency

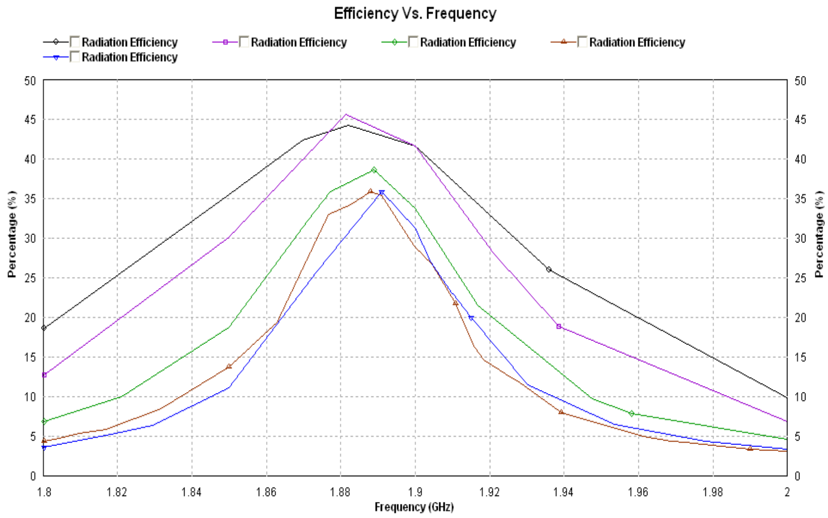


Figure 8: Radiation Efficiency Vs Frequency Curve

Quantitative analysis for all the designed geometries are given in table 2 below:-

Table 2 Antenna parameter comparison for Microstrip Feed Slotted Patch Antenna

Antenna Type	Return Loss	Directivity	Gain	Antenna Efficiency (%)	Radiation Efficiency (%)
Basic Patch	-13	6.31	2.5	42	45
Array using two basic patches	-9	6.32	5.8	40	44
Array using four basic patches	-35	12.8	8.5	38	38
Array using eight basic patches	-24	15.8	11.8	35	35
Array using sixteen basic patches	-25	18.1	13.9	36	36

VII. CONCLUSION

In this paper the work of patch array antennas have been proposed, designed and simulated from its basic patch antenna design. Observations are made on the various antenna parameters such as return loss, VSWR Radiation pattern etc. in all the proposed cases. From the results of the simulation, it has been observed that the influencing parameters of the antenna are as when we increase the number of array, the directivity, gain and antenna efficiency increases accordingly. It is also noticeable that increment in some antenna parameter counter balances other parameters.

VIII. REFERENCES

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