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Enhancement the Gain of Micro Strip Patch Antenna Using Array Configuration Technique

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Abstract:
A method to enhance the gain of micro strip patch antenna is investigated by array configuration technique. Array configuration technique improves the gain of micro strip patch antenna by increasing the effective aperture area. The effect of array configuration technique in different configurations has been studied numerically and validated experimentally. It is observed that with increase in effective aperture area, the gain of micro strip patch antenna is increased. A technique to increase the effective aperture area is place a number of patches on single dielectric substrate. Compared to single patch antenna, a double patch antenna provides high gain.

Keywords: *micro strip patch antenna, array, gain, return loss*

1. Introduction

Micro strip patch antennas are widely used due to being compact, conformal, and low cost. However micro strip patch antenna is provided with very low gain. Thicker substrate can increase the gain to some extent but may lead to undesired effects like surface wave excitation. Surface wave decreases efficiency and perturb the radiation pattern [3]. However, making the ground plane larger also increases the gain up to some extent but as the ground plane size increases, diffraction near the edges plays less of role and increasing the size of already large ground plane has very little effect on gain.

In communication system micro strip antennas are used in array as well as single element. Use of array in communication system enhanced the performance of micro strip patch antenna like gain, return losses, directivity etc. [4][1] In array configuration technique patches can be arranged in two ways: linear array and phase array. Linear array allowed patches along the straight line and is simple configuration. In phase array configuration, a phase of ɵ degree is applied between the patches. [4].

In this paper the effect of linear array configuration technique on the micro strip patch antenna are investigated to explore an effective simple way to enhance the gain of micro strip patch antenna. The basic idea is to improve the gain of micro strip patch antenna by increasing the effective aperture area of antenna [1]. Micro strip antenna is designed to operate at 3.4 ghz. In the present work instead of series feed network Corporate feed network is used to assign feed to the patches. In series feed network a minor change in first stage feed line may cause large effect on the performance of patch antenna [2][6]. Section II summarize the single patch antenna. Different configurations having multiple patches to improve the gain of patch antenna are investigated in section III. Section IV summarizes the findings with conclusions.

2. Micro strip Patch Antenna with Single Patch

Consider a conventional patch antenna at 3.4 ghz on a dielectric substrate FR4 with $E_r = 4.4$. the geometry of single patch antenna is shown in fig (1) the patch of length $L_p = 35.125$mm, width $W_p = 11.575$mm is positioned in the centre of 90×50 mm^2 ground plane. The width of feeding strip L_s is 0.1158.

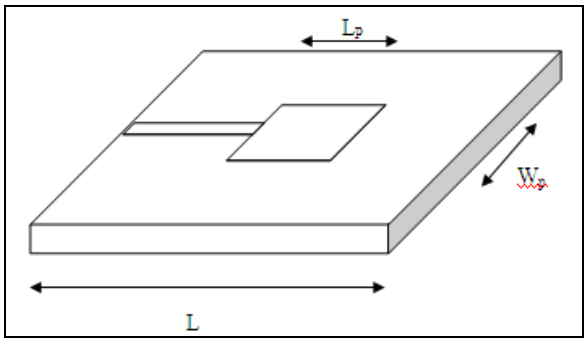

Figure 1: Geometry of single patch antenna Following the Figure 1, designed single patch antenna with simulated results is shown below

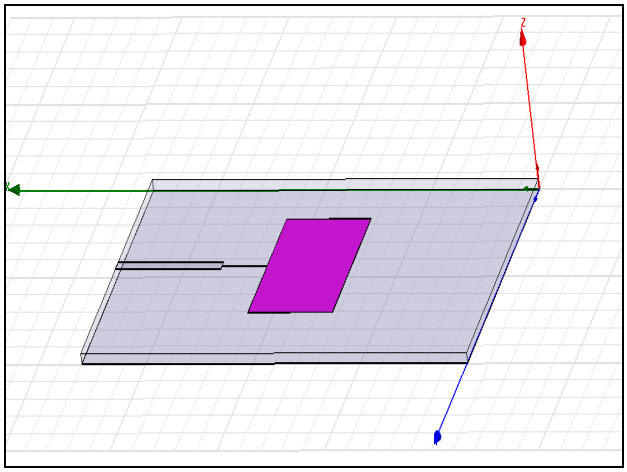

Figure 2(a): single patch antenna using HFSS

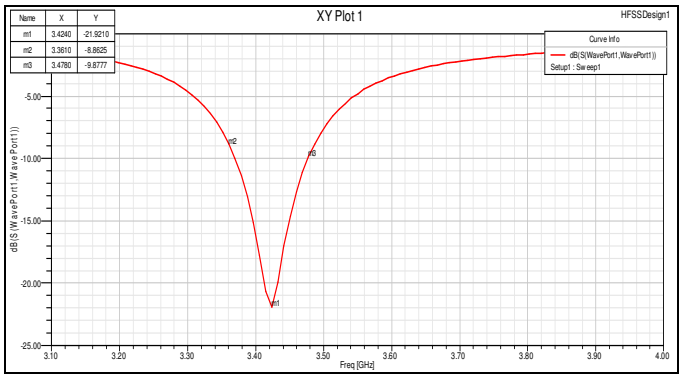

Figure 2(b): s parameter of single patch antenna

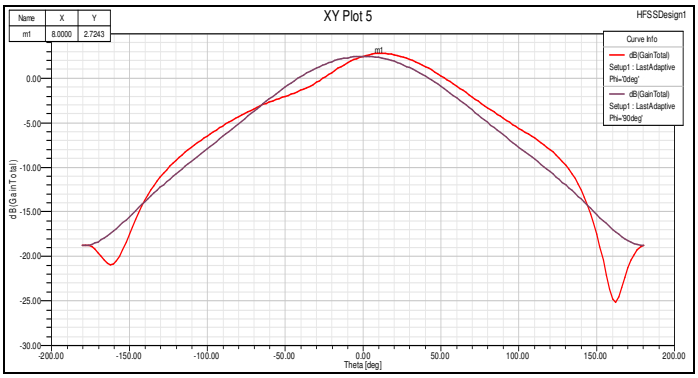

Figure 2(c): gain of single patch antenna

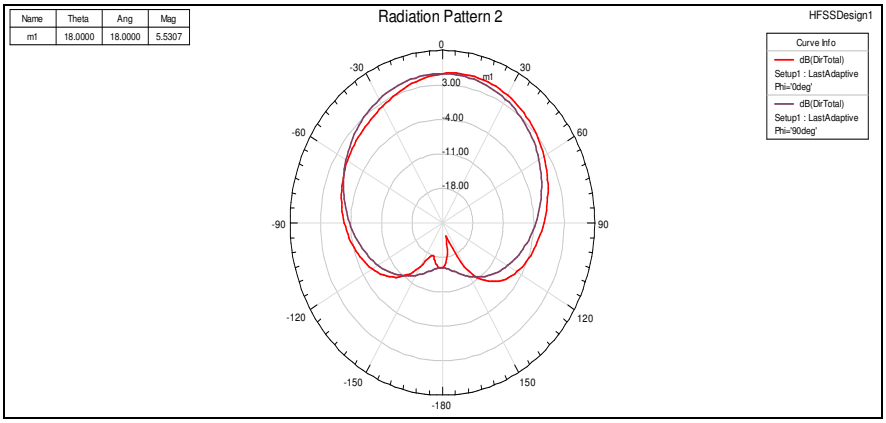

Figure 2(d): directivity of single patch antenna

Gain of single patch antenna is very low as shown in Figure 2(c). the characteristics of patch antenna can be improved by using multiple patches instead of single patch.
In this paper, the technique used to improve the performance the patch antenna involves multiple patches on a single substrate than a single patch; various configurations for better performance are shown below.

3. Multiple Patch Antenna

1×2 patch antenna

Micro strip patch antenna with two patches is shown in Figure 3

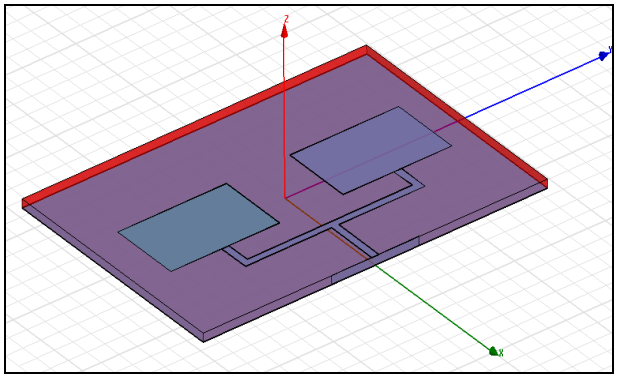

Figure 3(a): 1×2 micro strip patch antenna

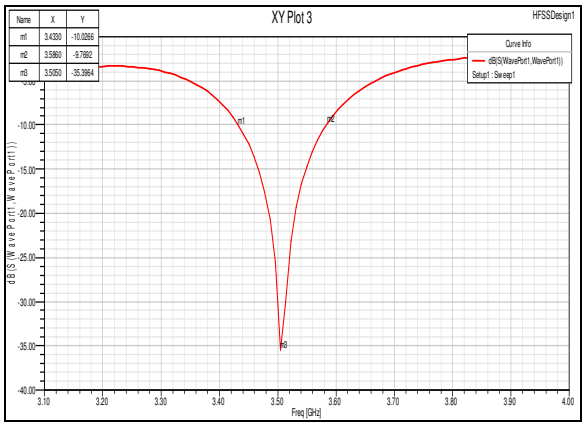

Figure 3(b): s parameter of 1×2 micro strip patch antenna

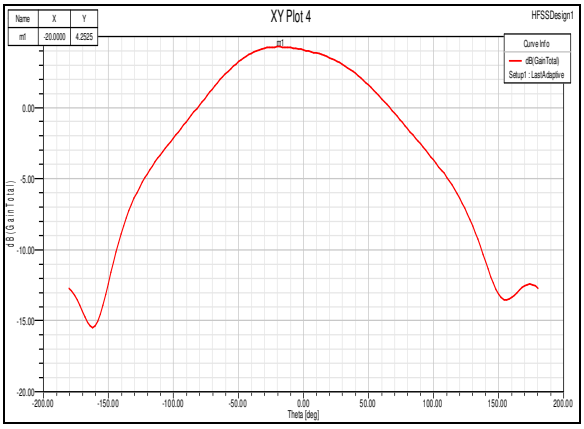

Figure 3(c): gain characteristics of 1×2 micro strip patch antenna

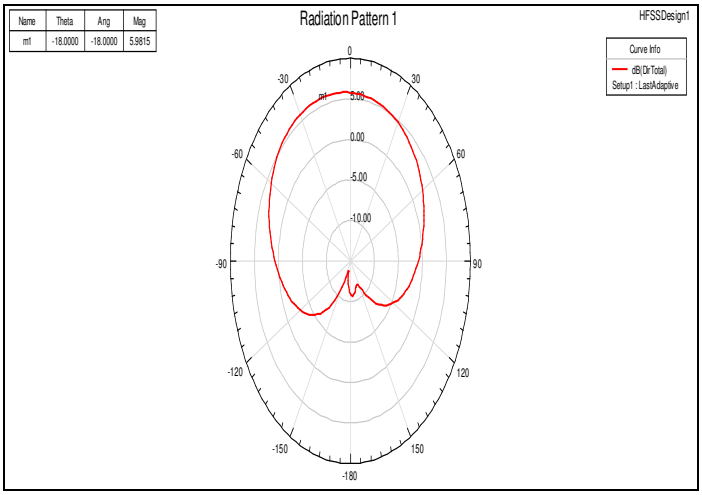

Figure 3(d): directivity of 1× 2 micro strip patch antenna

It has been observed that the performance of double patch antenna is better than single patch antenna. Configurations to enhance the gain of micro strip patch antenna are shown below.

1×4 patch antenna

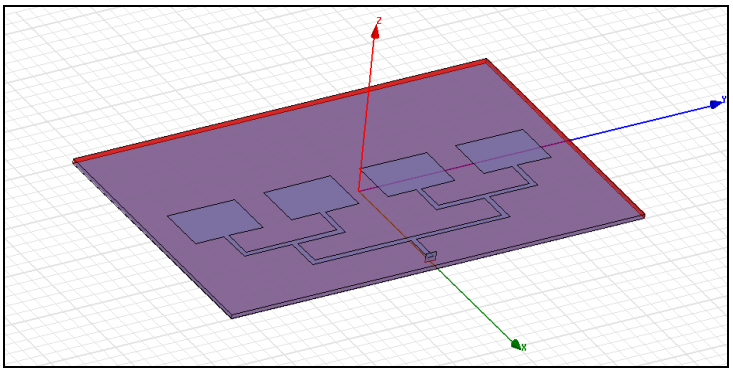

Figure 4(a): 1×4 micro strip patch antenna

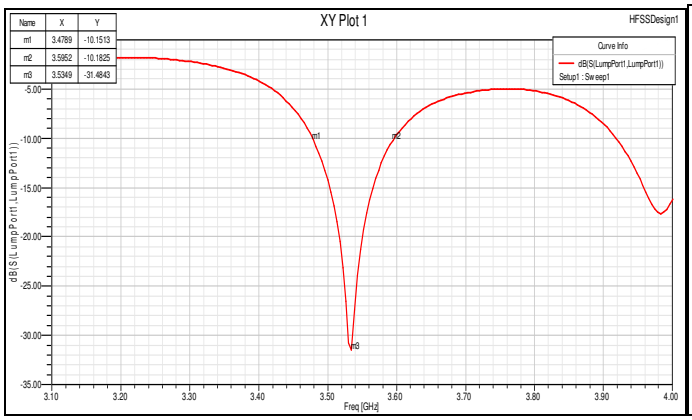

Figure 4(b): s parameters of 1×4 micro strip patch antenna

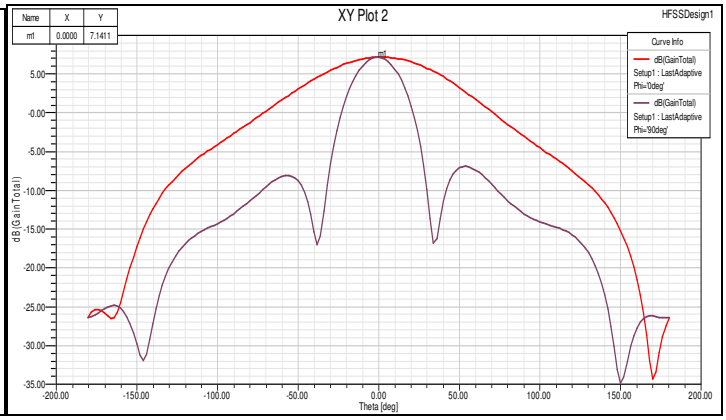

Figure 4(c): gain of 1×4 micro strip patch antenna

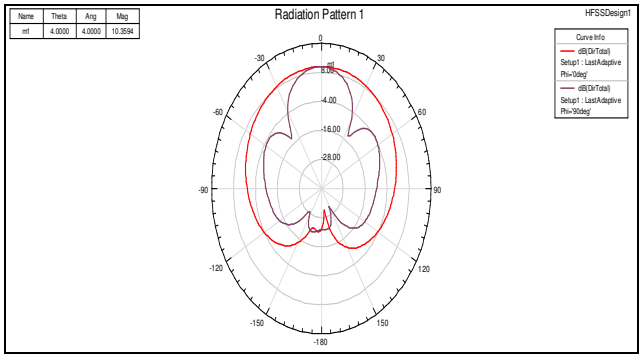

Figure 4(d): directivity of 1×4 micro strip patch antenna

Designed antennas shows that performance of micro strip patch antenna improves with improvement in effective aperture area. Performance characteristics of two and four patch antennas are compared in table 1

Designed antenna	S parameter	Gain	Directivity
1×2 patch antenna	-35.3 db	4.2 dbi	5.97 dbi
1×4patch antenna	-31.48 db	7.14 dbi	10.359 dbi

Table 1: 1×8 micro strip patch antenna

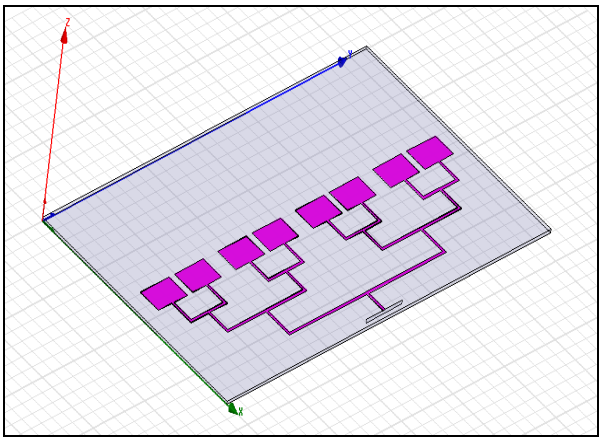

Figure 5(a): 1×8 micro strip patch antenna

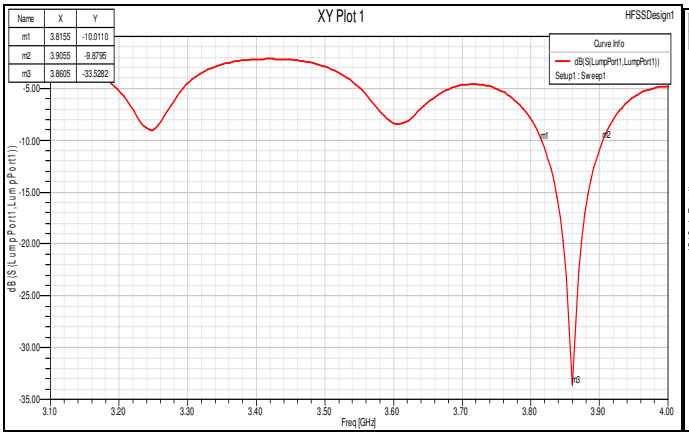

Figure 5(b): s parameter of 1×8 micro strip patch antenna

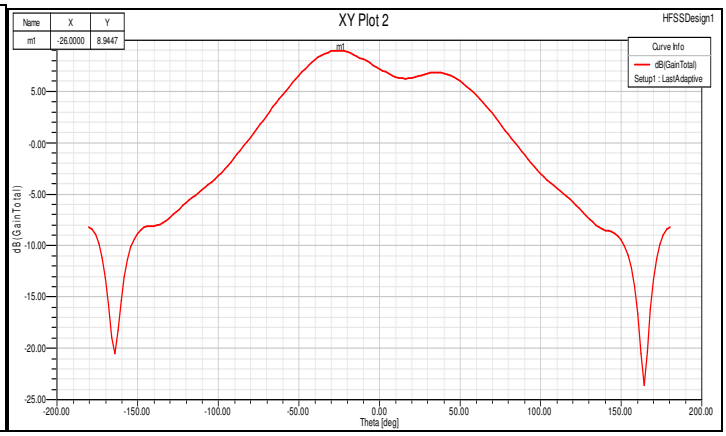

Figure 5(c): gain of 1×8 micro strip patch antenna

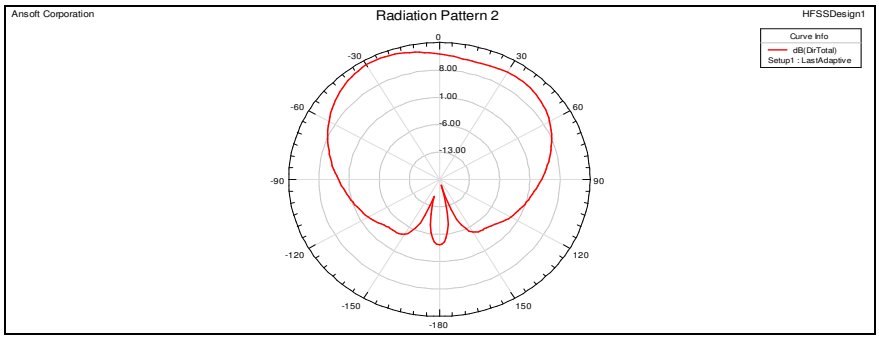

Figure 5 (d): directivity of 1×8 micro strip patch antenna

1× 16 patch antenna

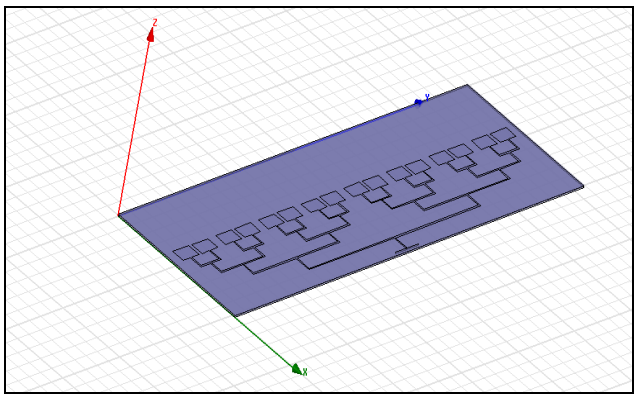

Figure 6(a): 1× 16 micro strip patch antenna

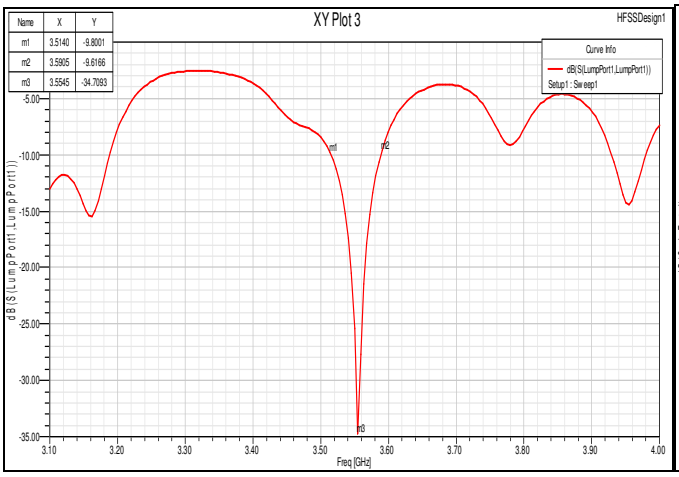

Figure 6(b): s parameter of 1× 16 micro strip patch antenna

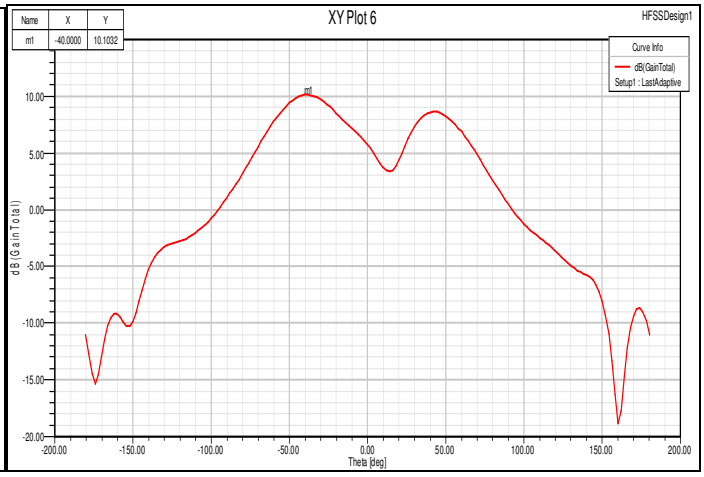

Figure 6(c): gain of 1× 16 patch antenna

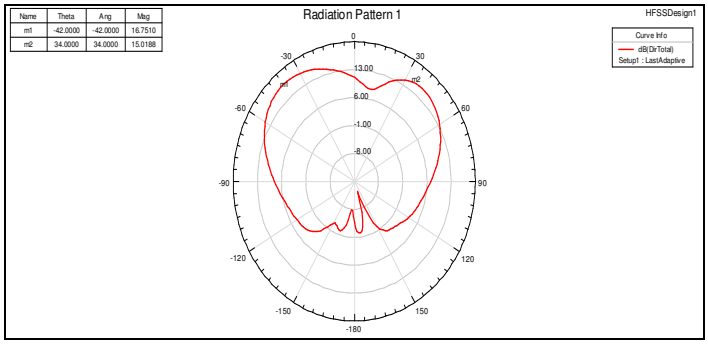

Figure 6(d): directivity of 1× 16 patch antenna

Calculated Parametric values shows that as we increase the number of patches on the substrate, the gain of micro strip patch antenna improves. The performance comparison of micro strip patch antenna with 8 and 16 elements is described in table 2

Designed Antenna	S parameter	Gain	Directivity
1× 8 micro strip patch antenna	-33.52 dB	8.94 dBi	13.87 dBi
1× 16 micro strip patch antenna	-34.70 dB	10 dBi	16.75 dBi

Table 2: performance comparison of 1× 8 and 1× 16 micro strip patch antenna

4. Conclusions

The effect of array configuration technique on micro strip patch antenna has been studied and validated numerically. It has been seen that by arranging the patches on the substrate in the form of array improves the gain and other characteristics like directivity and return losses of micro strip patch antenna. The gain of micro strip patch antenna has been improved from 2.72dBi to 10dBi. The proposed antenna is operating at 3.5 Ghz which is applicable in WLAN and communication applications.

5. References

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