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Design of Microstrip Patch Antenna For Enhancement of Gain Using Superstrate Layer and Array

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Abstract

Superstrate layer is a additional layer over the substrate. The gain of an antenna can be enhanced by choosing suitable thickness and permittivity of a superstrate layer. Antenna array is a configuration of multiple antennas arranged to achieve a radiation pattern and gain. In this paper the proposed antenna has gain of about 4db and achieved very low return loss(-98db).

Keywords: Superstarte layer, Array, Gain, Radiation Pattern, Return loss

Introduction

In Wireless local area Network application(WLAN), antennas of high gain and directivity are needed. By using antenna arrays we can achieve these characteristics even though it occupies more space. Array is a set of spatially separated antennas which are arranged in a specific constructive manner. The radiation pattern of antenna array depends on type of individual elements, total number of elements and orientation. To change the radiation pattern electronically through the control of phase and amplitude of the signal feed to each element.

Now a days the superstrate layer is used in split ring resonator and microstrip patch antenna array. Superstrate layer is the addition of dielectric layer over the substrate. The properties of antenna like resonance frequency, gain, bandwidth can be increased by choosing appropriate thickness and permittivity of superstrate layer. High permittivity and thin superstrate increases the gain of an antenna.

In Microstrip patch antenna the substrate is sandwiched in between patch and ground plane whose permittivity should be in range of $2.2 \leq \varepsilon_r \leq 12$. Patch antennas are widely used in cellular phones, radar systems and wireless communications systems because of its low profile. The patch antenna is used as a elements of array due to its ease of fabrication and planar configuration. The disadvantage is, it has low gain and low efficiency. To outcome this disadvantage, introduced a layer above the patch and array setup. The resonant frequency of patch antenna depends on length of the patch.

The proposed antenna is mounted on a a square patch of Roger RT/duroid 6010 substrate whose permittivity is 10.2.accordingly for high permittivity of substrate , the superstrate layer permittivity is low.The antenna is performed in HFSS(High Frequency Structure Simulator).HFSS is an industry standard simulator tool for 3D full wave electromagnetic simulator. It is essential for the design of high frequency and high speed components design.

Design Specifications:

Design parameters of microstrip patch antenna are length, width, thickness of the patch is 6.6 mm, 6.6mm, 0.05mm respectively. The length, width, thickness of substrate is 14mm, 14mm, 1.27mm respectively. Relative permittivity of substrate is 10.2.The patch model is shown in figure 1 and table 1

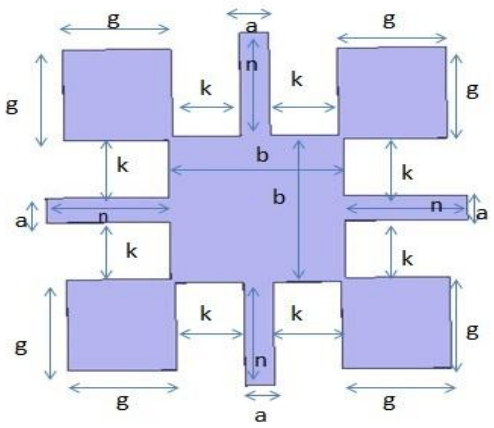

Figure 1: Dimensions of patch

Table 1: Measurements of patch

Labels	Dimensions
G	1.7mm
A	0.46mm
N	1.93mm
K	1.1mm
B	2.74mm

The antenna has coaxial feed in position (3.3, 3.3,0), inner and outer radius is 0.05mm and 0.17mm. The antenna is modelled by using HFSS is shown in below figure 2

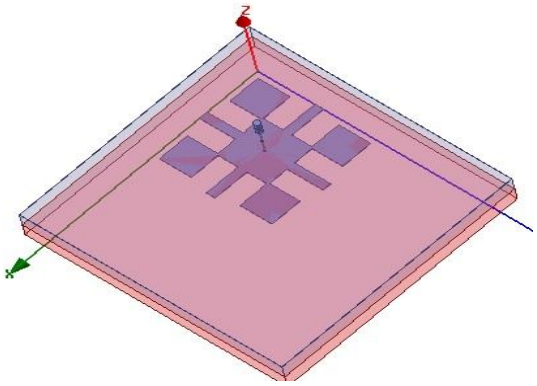

Figure 2: Microstrip Patch Antenna

To enhance the gain of antenna. The antenna is modified by placing number of elements in array in X and Y axis. The dimensions of modified antenna is given in table2.

Table 2: Modified Dimensions of antenna

Length of the dielectric layers	19.9mm
Width of the dielectric layers	16.9mm
Height of the dielectric layers	1.27mm
Relative permittivity of substrate layer	10.2(roger Rt/duroid 6010)
Length of the ground	19.9mm
Height of the ground	16.9mm
Material of the ground	PEC
Distance between patches	1.4mm

By planting the elements in X and Y directions, the antenna is influenced by mutual coupling which effects gain, return loss and efficiency. To mitigate this another dielectric material of 2.2 is placed on above the substrate. The measurements of superstrate layer is shown in Table3.

Table 3: Dimensions of Superstrate layer

	Dimensions
Length of Superstrate Layer	19.9mm
Width of superstarte layer	16.9mm
Height of superstrate layer	1.27mm

The overall patch antenna array with superstrate layer is shown in figure 3.The different slots in figure is tabulated in table 4.

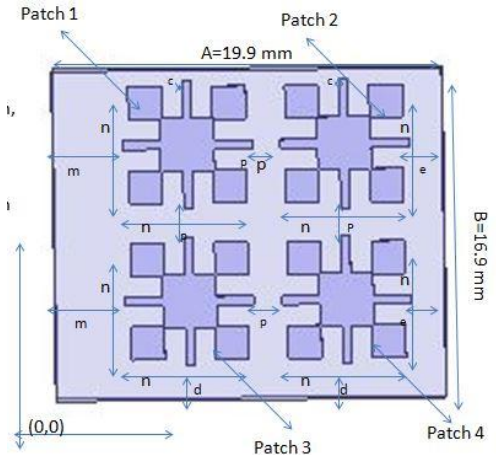

Figure 3: Antenna array with superstrate layer

Table 4: Size of slots in figure 3

Index	Measurments
m	3.6mm
n	6.6mm
p	1.4mm
c	0.5mm
d	1.5mm
e	1.7mm

The distance of different cells between probe feeding from the unitcell in X-axis and Y-axis is 8mm, 8mm respectively. The inner and outer radius of the coaxial feed is 0.05 and 0.17 respectively.

Results and Discussions

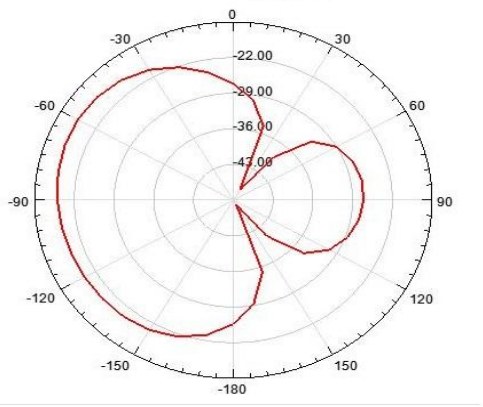

Figure 4: Radiation pattern

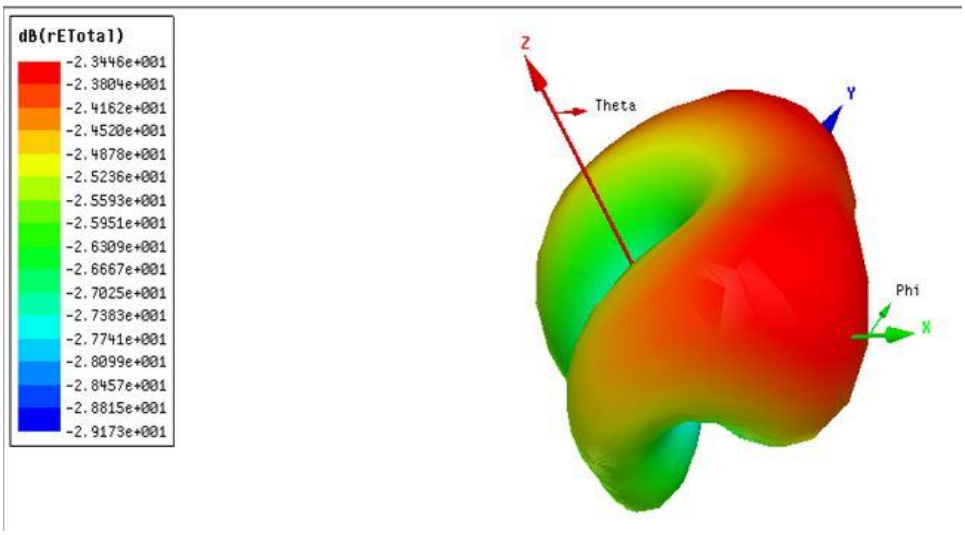

Figure 5: 3D Radiation Pattern

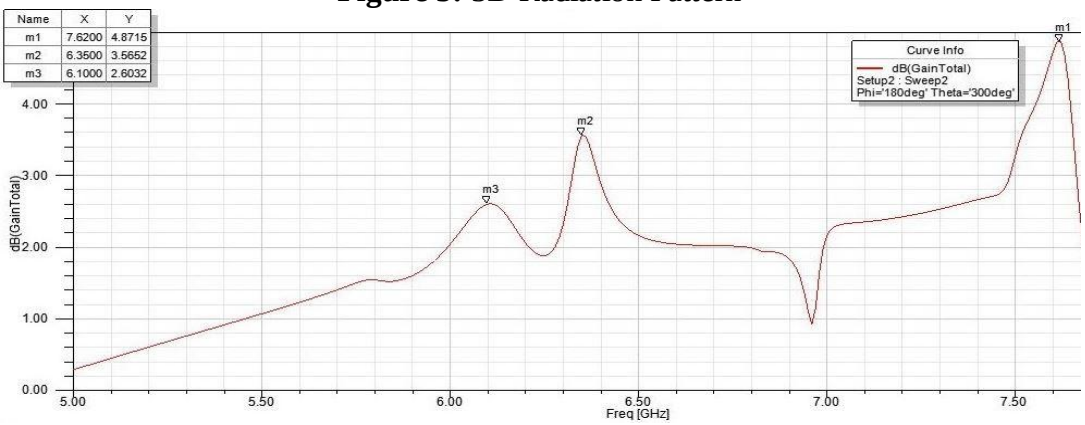

Figure 6: Return loss

From figure 6 the return loss is -98 db converged at frequency 7.45 GHz. Antenna works efficiently at this frequency. Efficiency of this antenna is 89.3% .

The gain of the single antenna through simulator is 1.4db. The gain is enhanced by increasing number of elements and observed virtually through ansoft is tabulated in table 5 which is practically not possible.

Table 5: Gain of The Antenna Array

No.of elements	*Gain(db)*
2	1.9
3	4.35
4	7.54
6	15.8
8	25.7
10	37.5
12	53.17

The gain pattern of two elements in X and Y direction is shown in figure 6.

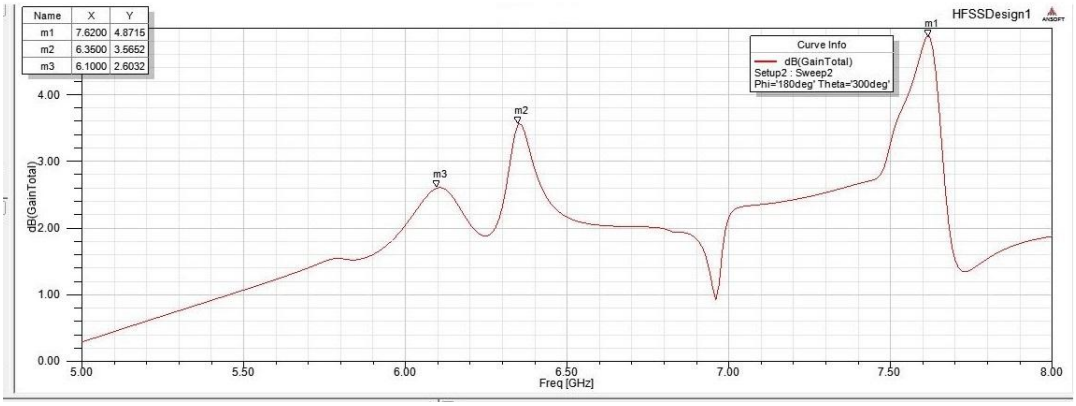

Figure 7: Gain

Conclusion

Microstrip patch antenna is designed and analysed using superstrate layer and array in Ansoft HFSS. Gain is augmented to 4.8 db at 7.45 GHz frequency.

Future Scope

This work can be prolonged by using EBG structures and superstrate concept in reducing mutual coupling in multi band antenna array applications.

References

[1] Balanis C.A. 1997. Antenna theory, analysis and design. Johnwiley & sons, NewYork.

[2] Samir Dev Gupta and Amit Singh 2012. "Design and analysis of multidielectric layer microstrip antenna with varying superstrate layer

characteristics", International Journal Advances in Engineering and Technology.

[3] Hossein Sarbandi Farahani, Mehdi Veysi, Manouchehr Kamyab, and Alireza Tadjalli 2010. "Mutual Coupling Reduction in Patch Antenna Arrays Using a UC-EBG Superstrate", IEEE Antennas and Wireless propagation letters, VOL. 9.

[4] Eva Rajo-Iglesias, Senior Member, Óscar Quevedo-Teruel, and Luis Inclán-Sánchez 2008. Mutual Coupling Reduction in Patch Antenna Arrays by Using a Planar EBG "Structure and a Multilayer Dielectric Substrate", 1648 IEEE transactions on Antennas and propagation, VOL. 56, No. 6.

[5] Indrasen Singh, Dr. V.S. Tripathi , "Micro strip Patch Antenna and its Applications: A Survey"**,** J. Comp. Tech. Appl., Vol 2 (5), 1595-1599.