iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 Issue: VI Month of publication: June 2021

DOI: https://doi.org/10.22214/ijraset.2021.35050

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VI Jun 2021- Available at www.ijraset.com

Analysis of Beam Forming Antenna using Soft-Computing Techniques

Bhavyasri Maddineni[1], Sushma Sheshita Dulam[2], Champabai Chowhan[3], V. Sudha Rani[4]
[1, 2, 3]Student, [4]Associate Professor, ECE, Sreenidhi Institute of Science and Technology, Ghatkesar, Hyderabad

Abstract: Antenna Beam forming is a technology or a technique that is finding increasing use in systems of cellular telecommunication, especially 5G, as well as many other wireless systems. Beam forming refers to the formation of a beam of energy from a set of phased arrays. With the use of phased arrays, it is possible to control the direction and shape of the beam from multiple antennas, based on the spacing between antennas and the phase of signal from each antenna element in the array. Beam forming focuses a wireless signal towards a specific receiving device, rather than having the signal spread in all directions from the broadcast antenna. By focusing signal in specific direction, the beam forming technique allows delivery of higher signal quality to the receiver, which would result in faster information transfer with fewer errors and without the need to boost the broadcast power. Beam forming technique is also used to reduce the interference of signals. Beam forming is majorly involved with computing resources which requires high time and power resources. Parameters that would be analyzed during this project are Half Power Beam width (HPBW), First Null Beam width (FNBW), Gain, Voltage Standing Wave Ratio, Front to Back Power Ratio, Side Lobe Levels.
Keywords: Gain, Directivity, Radiation pattern, HPBW, VSWR.

I. INTRODUCTION

An Antenna has a radiating element which radiates electro-magnetic waves in a particular direction.
For the radiation to be more directive we use a single antenna with multiple radiating elements and feed it with same signal. Example: If there are two radiating elements in an antenna then the energy in forward direction is two times the energy that would be in the case of single radiating element, and if there are four radiating elements in an antenna then the energy in forward direction is four times the energy that would be in the case of single radiating element, and so on.

In the above case the radiation looks as below:

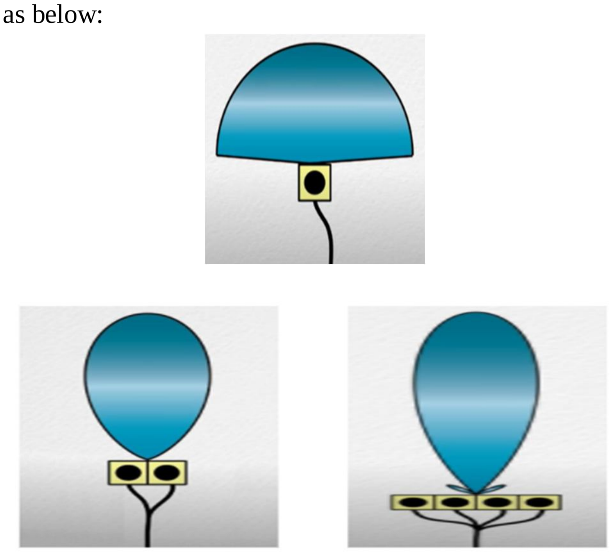


Fig 1. Radiation pattern of antenna
a. with one radiating element
b. with two radiating elements c. with four radiating elements

To get different direction of radiation, each radiating element in antenna is fed with different signal.

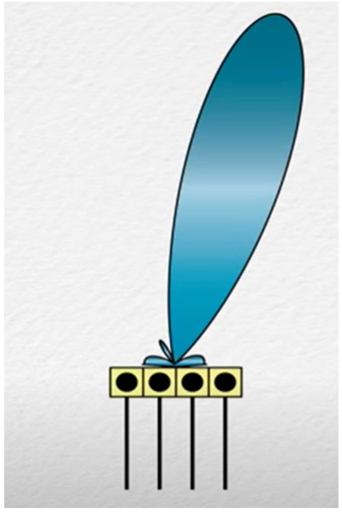


Fig 2. Radiation pattern of antenna with each radiating element fed with different signal

To achieve radiation in different directions the signal is fed with different amplitude and phase.

II. LITERATURE REVIEW

A. *Microstrip Patch Antenna Arrays Based On Conventional Geometries*

In this paper, several designs of microstrip patch array antennas such as rectangular, triangular, circular and hexagonal are studied. The shapes are designed and simulated using CADFEKO. In the initial stage, the comparison between different shapes was carried out using single radiating element. And it is concluded from first stage that hexagonal configuration has good gain. In the next steps, the number of radiating elements increased, which resulted in the increase of gain and decrease of HPBW. From this study it is concluded that circular patch microstrip array antenna has high gain and hexagonal patch microstrip array antenna has low HPBW.

B. *Comparison Of Performance Characteristics Of Rectangular, Square And Hexagonal Microstrip Patch Antennas*

In this paper, different patch microstrip configurations such as rectangular, square, hexagonal are compared. Same frequency of operation, material and feeding technique is used for all.

Results from simulation are as follows:

1) The rectangular and square microstrip patch antenna has nearly equal and maximum allowable bandwidth.
2) Both rectangular and square microstrip patches has almost same radiation pattern.
3) Feed line impedance provides a good input-output matching in the antenna and ideally its value is taken as 50 Ω.

The comparative simulation between different patch microstrip antennas is performed using HFSS software.

The following conclusions are made:

a) Resonant frequency and Radiation pattern have a significant effect on changing the feeding mode.
b) Nature of antenna is modified by changing the dielectric substrate.
c) Square configuration results in a reduced size of patch which would be useful in wireless communication.
d) Hexagonal shaped patch has improved gain and radiation pattern.
e) Both rectangular and hexagonal shaped patch has improved gain.

C. *Microstrip Patch Antenna Design Calculator*

In this paper, various properties of Metamaterials and Parameters of antenna namely actual and effective length, width, radiation power, directivity, voltage standing wave ratio (VSWR), which dictates the ultimate performance of antenna are determined by simulation using a GUI developed in MATLAB.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VI Jun 2021- Available at www.ijraset.com

III. DESIGN PARAMETERS

$f = frequency\ of\ operation$
$\epsilon_r = dielectric\ constant\ of\ substrate$
$h = height\ of\ dielectric\ substrate$
$W = width\ of\ patch$
$\epsilon_{eff} = effective\ dielectric\ constant$
$L_{eff} = effective\ length\ of\ patch\ antenna$
$\Delta L = length\ extension$
$L = length\ of\ patch$
$L_g = ground\ plane\ length$
$W_g = ground\ plane\ width$
$z = characteristic\ impedance$

IV. RECTANGULAR PATCH MICROSTRIP ANTENNA

Rectangular shaped patch is the most commonly employed microstrip antenna.

A. *Single Radiating Element*

Considerations

1) Frequency of operation: 800 MHz
2) Dielectric Substrate: Air
3) ϵ_r: 1

B. *Multiple Radiating Elements (Array Antenna)*

Considerations

1) Frequency of operation: 800 MHz
2) Dielectric Substrate: Air
3) ϵ_r: 1
4) Spacing between radiating elements: 0.2342 m

C. *Result*

Number of Antenna Elements	Max. Gain (Main Lobe) (dB)	Half Power Beamwidth (deg)	First Null Beamwidth (deg)	Voltage Standing Wave Ratio	Front to Back Power Ratio	Side Lobe Level (dB)
1	-7.4	51	96	1.10349	0.232	0.00499
2	-7.33	49	103	1.03075, 1.069	0.2	0.0139
3	-5.4	28	67	1.03466, 1.23959, 1.04623	0.0739	0.0739
4	-4.38	21	48	1.07913, 1.24489, 1.23101, 1.05353	0.0075	0.0075
5	-3.56	18	37	1.07363, 1.19692, 1.16333, 1.24688, 1.13494	0.0246	0.0246

Table 1. Analysis results of various parameters by varying number of radiating elements in a rectangular patch microstrip array antenna

V. SQUARE PATCH MICROSTRIP ANTENNA

Square Patch Antenna is designed from Rectangular Patch Microstrip Antenna by considering both length and width of square patch equal to width of rectangular patch.

Square Patch Microstrip Antenna is the most commonly used Microstrip Antenna in wireless communication.

A. *Single Radiating Element*

Considerations

1) Frequency of operation: 800 MHz
2) Dielectric Substrate: FR4
3) ϵ_r: 4.8

B. *Multiple Radiating Elements (Antenna Array)*

Considerations

1) Frequency of operation: 800 MHz
2) Dielectric Substrate: FR4
3) ϵ_r: 4.8
4) Spacing between radiating elements: 0.085 m

C. *Result*

Number of Antenna Elements	Max. Gain (Main Lobe) (dB)	Half Power Beamwidth (dB)	First Null Beamwidth (dB)	Voltage Standing Wave Ratio	Front to Back Power Ratio	Side Lobe Level (dB)
1	-2.23	360	-	1.00998	-	-
2	0.449	98	180	2.28079, 6.09441	1.24	0.0952
3	0.647	81	180	1.9371, 1.97924, 1.82376	0.659	0.0223
4	1.08	68	180	2.06932, 2.05441, 2.10032, 2.08296	0.296	0.059
5	2.84	36	135	2.18497, 6.6942, 2.37948, 2.41143, 1.66577	0.619	0.0214
6	3.21	37	98	1.86923, 2.0419, 2.12498, 2.10333, 2.10648, 1.90566	0.0662	0.0359
7	3.84	32	80	1.87487, 2.0589, 2.03006, 2.13301, 2.08654, 2.03078, 1.90811	0.0813	0.0442
8	2.29	37	67	1.75765, 1.1606, 5.25538, 2.58373, 2.29344, 1.96072, 1.91139, 5.68186	0.306	0.306
9	4.32	27	61	1.68979, 1.97891, 1.8409, 1.29086, 1.72318, 1.99025, 1.92056, 1.84361, 1.42503	0.751	0.544
10	5.04	21	64	1.73771, 1.97961, 1.99685, 2.02185, 2.05592, 2.02172, 4.19656, 71.7663, 2.33776, 2.94485	0.092	0.00777

Table 2. Analysis results of various parameters by varying number of radiating elements in a square patch microstrip array antenna

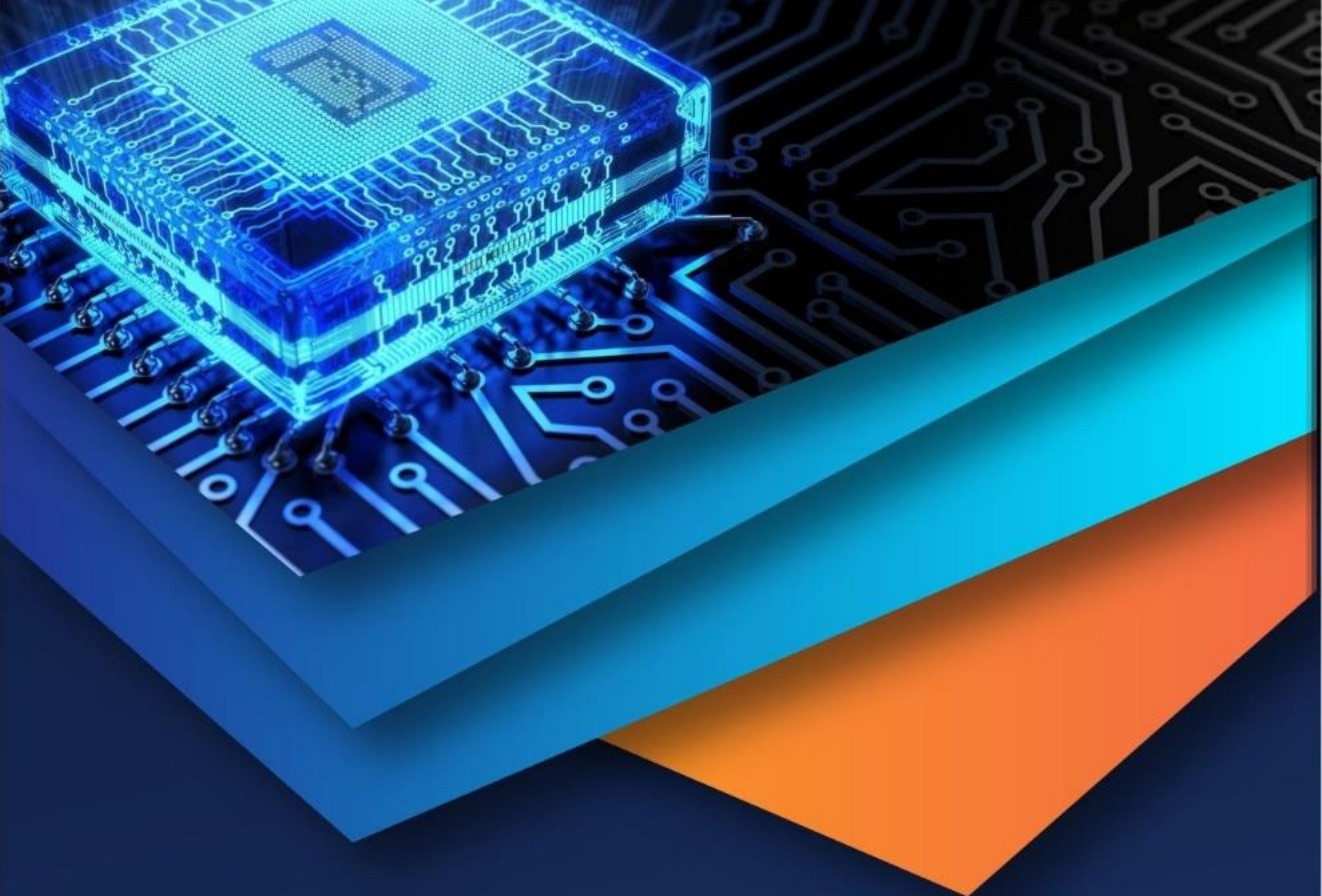
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VI Jun 2021- Available at www.ijraset.com

VI. CONCLUSION

A. Rectangular Patch Microstrip Antenna is used due to its high gain and directivity. Also, it is the most widely used configuration in microstrip antennas.
B. The analysis is performed on the rectangular configuration and the results are tabulated.
C. Square Patch Microstrip Antenna is used as it has reduced size and narrow-band. Also, it is the most widely used configuration in wireless communication.
D. The analysis is performed on the square configuration and the results are tabulated.
E. On comparing the results of both configurations it can be concluded that, square configuration has higher gain and directivity.

REFERENCES

[1] Antenna Theory Analysis and Design by Constantine A. Balanis
[2] Comparison of Performance Characteristics of Rectangular, Square and Hexagonal Microstrip Patch Antennas by Vinita Mathur, Dr. Manisha Gupta
[3] Design and Analysis of Microstrip Patch Antenna Arrays by Ahmed Fatthi Alsager
[4] Finding the best Feeding Point Location of Patch Antenna using HFSS by S. E Jasim, M. A. Jusoh, M. H. Mazwir and S. N. S. Mahmud
[5] Microstrip Patch Antenna Design Calculator by Mosin I Memon and Prof. Anurag Paliwal
[6] Microstrip Patch Array Antennas based on Conventional Geometries by Ouadiaa Barrou, Abdelkebir El Amri, Abdelati Reha, Mohamed Tarbouch



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY