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Mushroom Shaped Microstrip Patch Antenna Array for Better Gain

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Abstract— This paper presents a mushroom shaped antenna array of rectangular topology which is designed to operate in Ku band. The antenna has been designed with 7 patches and rest of the patch potion is subtracted to obtain the required design. The operating frequency of the antenna array is 14.5 GHz. The designed patch antenna array is simulated on Rogers RT/duroid5880 substrate with dielectric constant of 2.2.The following paper shows steps for designing patch antenna array in Ku band and simulating the same.. The design is analysed by HFSS 15.0 by which s parameter, 3D polar plot, directivity, VSWR and gain of the antenna are computed. The results which are simulated by software show that the designed antenna provides better outputs in terms of gain, s parameter, and VSWR.

Keywords - patch antenna array, HFSS 15.0, s parameter, gain, VSWR, 3D polar plot.

I. INTRODUCTION

Now a days the need of huge big antennas are decreasing as they are difficult to handle and also acquire a large space. People want a system that is compatible to them and can solve their problem. Nobody wants such a big setup of each and every thing as that can be constructed in much smaller size that works more efficiently and has good performance. Everyone wants much smaller electronic devices that can be carried easily which is directly impacting the size of antennas. Due to advancement in technologies the communication devices are becoming small which in turn increases the need of highly selected antennas for specific functionality. Micro strip antennas are widely used for communication devices, in satellites, in biomedical etc. As this paper consists of patch antennas, so patch is a low profile that can generally mounted on another surface. Patch can be planar rectangular, triangular or of any other shape which in general mounted on the ground plane. Rectangular patch is mostly used among the all available designs. Different parameters like material of substrate, feeding techniques, dimensions of antenna, medium in which antenna is placed, are responsible for the performance of micro strip antenna. Frequency also plays a major role in behavior of antenna as if we change frequency the behavior and output of antenna will also change accordingly. The substrate which is mainly used rogers RT/duroid5880 with ϵr=2.2. the HFSS software which is full wave electromagnetic field simulator and have high performance ability. This software also used to analyze 3D pattern for behavior of antenna. This software design, analyzes, validate, and simulate the required antenna in accurate way and it is also easy to learn things on this.

II. BACKGROUND

A. S parameter

How energy can propagate through an electric field is being described by the S parameter. These are complex numbers that have magnitude and phase part. S parameters are used to show reflection or transmission characteristics of the antenna in the frequency domain.

B. Gain

In general antenna gain is the ability of the antenna to radiate power in specific direction or to absorb power coming from a specific direction.

C. Radiation pattern

Radiation pattern shows the energy radiated or distributed by the antenna in different directions. The diagrammatical representation of the distribution of the radiated energy into the space as a function of direction is called radiation pattern.

D. VSWR

Voltage Standing Wave Ratio (VSWR) measures the efficiency of RF power which is been transmitted by power source to the load and through the transmission line.

E. Directivity

It measures the degree of concentration ability of the emitted radiation in a single direction.

III. ANTENNA ARRAY

In modern days, an important role is being played by these antenna arrays in communication systems. Due to the low profile, less expensive, being easy in integration and fabrication, low power handling capacity and light weight of micro strip antennas, these are widely used in wireless communication systems. In order to obtain required gain and

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bandwidth these antenna arrays can be designed in any shape. Traditionally these patch antenna arrays are used in military radar applications.

Major advantages of antenna arrays are as follows:

Overall gain is increased

It cancels out the interference from a particular direction.

Improved radiation pattern and plot.

IV. DESIGN OF PROPOSED ANTENNA

In this paper mushroom shaped rectangular micro strip patch antenna array is designed at 14.5 GHz frequency (Ku band) and is being simulated in HFSS 15.0.

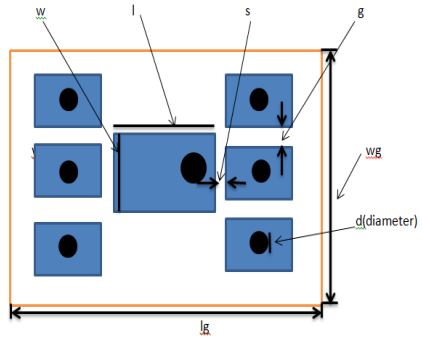

Fig 1 : Detailed image of proposed antenna

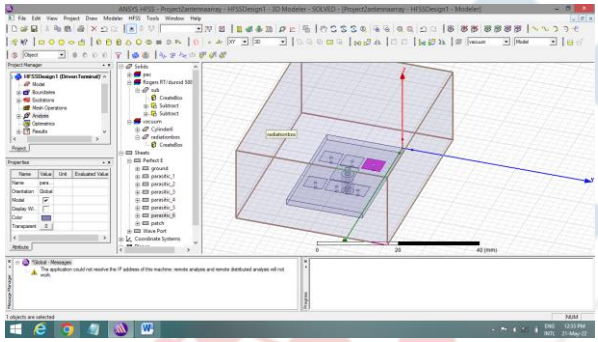

Fig 2 : Original image of antenna

Fig 1 represents the detailed image of the proposed micro strip patch antenna array and fig 2 is the original image of antenna array.In this technique I have used probe feeding.

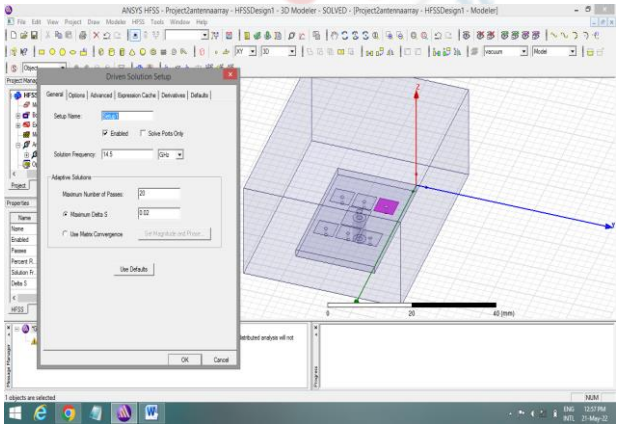

Fig 3 : Setup image of antenna

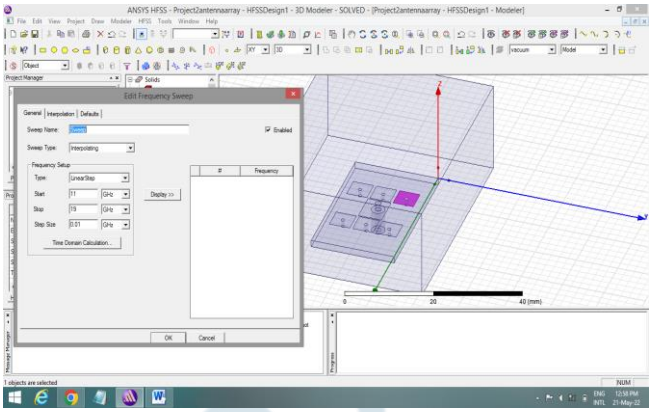

Fig 4 : Sweep image of the antenna

Table : Design parameters and considerations

Design parameter	***Value***
Operating frequency	14.5GHz
Dielectric constant	2.2
l	6.9mm
w	5.6mm
lg	32mm
wg	20mm
s	0.3mm
g	0.7mm
Height of substrate	1.5mm
d	0.8mm

V. RESULT SIMULATION USING HFSS 15.0

A. S parameter

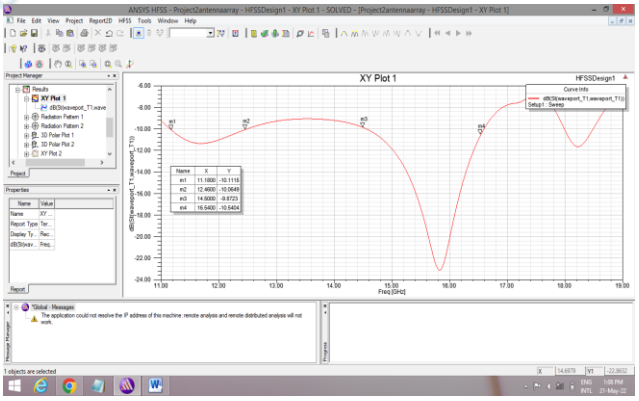

Fig 5 : s parameter of antenna array

The above figure shows this design has a value of -9.873db at 14.5 Ghz.

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B. Radiation pattern

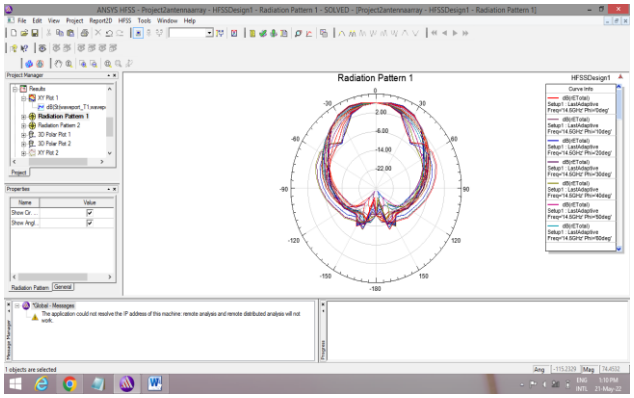

Fig 6 : Radiation pattern of antenna array

C. 3 D polar plot

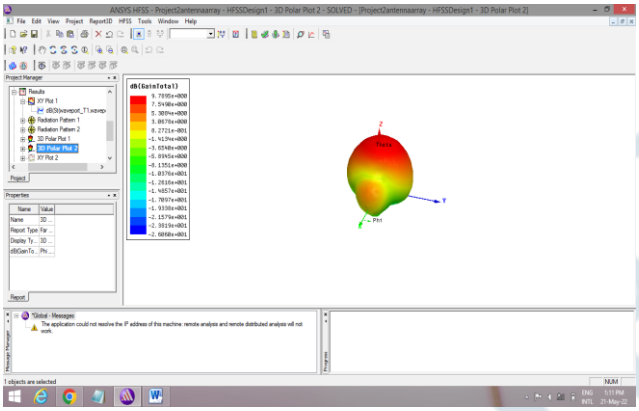

Fig 7 : 3 D polar plot of antenna array

D. VSWR

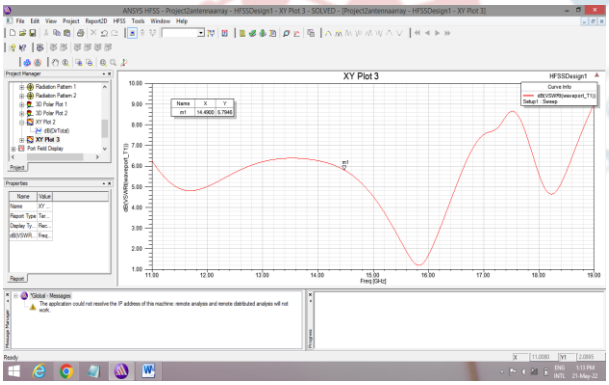

Fig 8 : VSWR curve of antenna array

The above curve shows value of 5.79db at 14.49 GHz.

E. Directivity

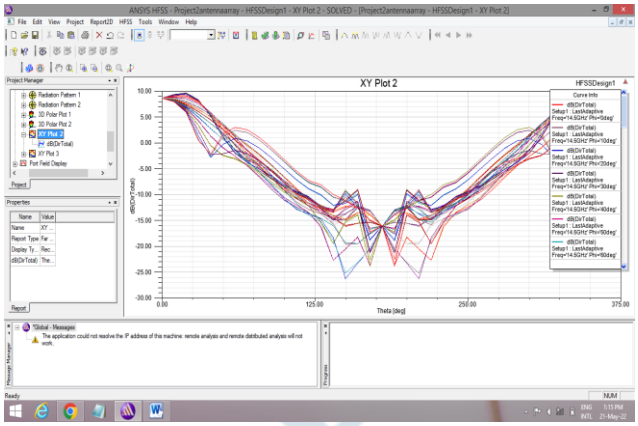

Fig 9 : Directivity curve of antenna array

F. E field pattern

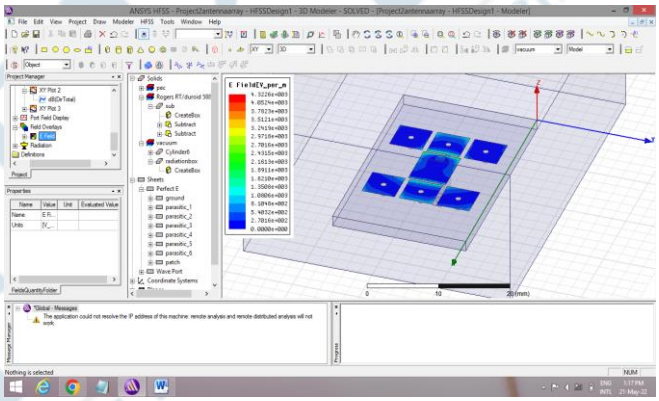

Fig 10 : E field pattern of antenna array

VI. CONCLUSION

This design of antenna array is proposed to improve gain and other parameters. Mushroom shaped patch antenna array design which is simulated on HFSS 15.0 is being explained in this paper. This design has a value of return loss as -9.873db at 14.5 Ghz, also gain and other parameters are improved. This paper concentrates on more improved gain and VSWR and then manufacture of this proposed design of antenna array.

REFERENCES

[1]. D. H. Nguyen, J. Ala-Laurinaho, J. Moll, V. Krozer and G. Zimmer, "Improved Sidelobe-Suppression Microstrip Patch Antenna Array by Uniform Feeding Networks," in IEEE Transactions on Antennas and Propagation, vol. 68, no. 11, pp. 7339-7347, Nov. 2020, doi: 10.1109/TAP.2020.2995416.

[2]. R. Hasan, W. A. Ahmed, J. Lu, H. J. Ng and D. Kissinger, " F -Band Differential Microstrip Patch Antenna Array and Waveguide to Differential Microstrip Line Transition for FMCW Radar Sensor," in IEEE Sensors Journal, vol. 19, no. 15, pp. 6486-6496, 1 Aug.1, 2019, doi: 10.1109/JSEN.2019.2909935.

[3]. H. Saeidi-Manesh and G. Zhang, "Low Cross-Polarization, High-Isolation Microstrip Patch Antenna Array for

Multi-Mission Applications," in IEEE Access, vol. 7, pp. 5026-5033, 2019, doi: 10.1109/ACCESS.2018.2889599.

[4]. K. S. Vishvaksenan, K. Mithra, R. Kalaiarasan and K. S. Raj, "Mutual Coupling Reduction in Microstrip Patch Antenna Arrays Using Parallel Coupled-Line Resonators," in IEEE Antennas and Wireless Propagation Letters, vol. 16, pp. 2146-2149, 2017, doi: 10.1109/LAWP.2017.2700521.

[5]. U. Rafique, H. Khalil and Saif-Ur-Rehman, "Dual-band microstrip patch antenna array for 5G mobile communications," 2017 Progress in Electromagnetics Research Symposium - Fall (PIERS - FALL), 2017, pp. 55-59, doi: 10.1109/PIERS-FALL.2017.8293110.

[6]. X. Yang, W. Geyi and H. Sun, "Optimum Design of Wireless Power Transmission System Using Microstrip Patch Antenna Arrays," in IEEE Antennas and Wireless Propagation Letters, vol. 16, pp. 1824-1827, 2017, doi: 10.1109/LAWP.2017.2682262.

[7]. Y. Li and K. -M. Luk, "60-GHz Substrate Integrated Waveguide Fed Cavity-Backed Aperture-Coupled Microstrip Patch Antenna Arrays," in IEEE Transactions on Antennas and Propagation, vol. 63, no. 3, pp. 1075-1085, March 2015, doi: 10.1109/TAP.2015.2390228.

[8]. Chirag Arora, Shyam Sundar Pattnaik, and Rudra Narayan Baral, "SRR Inspired Microstrip Patch Antenna Array," Progress In Electromagnetics Research C, Vol. 58,89-96,2015.doi:10.2528/PIERC15052501. http://www.jpier.org/PIERC/pier.php?paper=15052501

[9]. A. Mavaddat, S. H. M. Armaki and A. R. Erfanian, "Millimeter-Wave Energy Harvesting Using 4×4 Microstrip Patch Antenna Array," in IEEE Antennas and Wireless Propagation Letters, vol. 14, pp. 515-518, 2015, doi: 10.1109/LAWP.2014.2370103.

[10]. N Ashok Kumar, P Nagarajan, Mohanasundari. L, Joshuva Arockia Dhanraj, T Senthil Kumar, "Analysis of Millimeter-Wave based on Multichannel Wireless Networks-on-Chip," 2022 International Conference on Electronics and Renewable Systems (ICEARS), 2022, pp. 405-409, doi: 10.1109/ICEARS53579.2022.9752077.

[11]. G. Casu, C. Moraru and A. Kovacs, "Design and implementation of microstrip patch antenna array," 2014 10th International Conference on Communications (COMM), 2014, pp. 1-4, doi: 10.1109/ICComm.2014.6866738.

[12]. H. Sajjad, W. T. Sethi, K. Zeb and A. Mairaj, "Microstrip patch antenna array at 3.8 GHz for WiMax and UAV applications," 2014 International Workshop on Antenna Technology: Small Antennas, Novel EM Structures and Materials, and Applications (iWAT), 2014, pp. 107-110, doi: 10.1109/IWAT.2014.6958609.

[13]. K. Phalak and A. Sebak, "Aperture coupled microstrip patch antenna array for high gain at millimeter waves," 2014 IEEE International Conference on Communication, Networks and Satellite (COMNETSAT), 2014, pp. 13-16, doi: 10.1109/COMNETSAT.2014.7050517.

[14]. T. Mikulasek, A. Georgiadis, A. Collado and J. Lacik, "2$\,\times\,$ 2 Microstrip Patch Antenna Array Fed by Substrate Integrated Waveguide for Radar Applications," in IEEE Antennas and Wireless Propagation Letters, vol. 12, pp. 1287-1290, 2013, doi: 10.1109/LAWP.2013.2283731.

[15]. M. G. N. Alsath, M. Kanagasabai and B. Balasubramanian, "Implementation of Slotted Meander-Line Resonators for Isolation Enhancement in Microstrip Patch Antenna Arrays," in IEEE Antennas and Wireless Propagation Letters, vol. 12, pp. 15-18, 2013, doi: 10.1109/LAWP.2012.2237156.

[16]. B. R. Franciscatto, A. C. Souza, C. Defay, T. T. Trang and T. P. Vuong, "High gain microstrip patch antenna array using multiple superstrate layers for DSRC applications," 2012 IEEE-APS Topical Conference on Antennas and Propagation in Wireless Communications (APWC), 2012, pp. 736-739, doi: 10.1109/APWC.2012.6324937.

[17]. R. Jothi Chitra, B. Ramesh Karthik and V. Nagarajan, "Double L - slot microstrip patch antenna array for WiMAX and WLAN," 2012 International Conference on Communication and Signal Processing, 2012, pp. 137-140, doi: 10.1109/ICCSP.2012.6208410.