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Design of 2.4GHz patch antenna array for wireless applications

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ABSTRACT: in high performance applications where size, weight, cost and is of installation are constraints. For the applications such as aircraft, spacecraft and satellite and missile require low profile antennas. Patch antenna array exhibit wider band width and pencil beam directivity. The patch antenna concept has been used in patch antenna designed to increase patch antenna directivity. The structure of an antenna is simple to manufacture, versatile in nature and due to the small size it can be embedded in various portable devices. As Micro strip patch antenna array is best for its s-band characteristics, we prefer this. In these the patch antenna can be designed for WLAN, s-band and Bluetooth application by providing an array fed by coaxial cable. It has wireless applications which require pencil beam radiation pattern such as for covering wireless applications of WLAN. By using mat lab software package the parameters of the propose antenna are described and simulated using MATLAB software package.

KEYWORDS: antenna, low profile antenna, patch antenna array, s-band, coaxial cable, MATLAB

I.INTRODUCTION

Antenna array also called as array antenna, antenna arrays are several antennas connected and arranged in a regular structure to form a single antenna. Phased array antenna (PAA) is a multiple antenna system, in which that the radiation pattern can be rain forced in a particular direction and suppressed in desired direction. The direction of phased array radiation can be electronically starred obviating the need for any mechanical rotation. These unique capabilities found that the phased arrays a broad range of applications since the advent of this advanced technology. The single micro strip patch antenna fed with coaxial cable was firstly introduced by HUYNH and Lee in 1995 the advantage of using patch antenna is, the directivity increases. It is a low profile antenna, able to adapt to mini activities and can be easily carried. Patch antennas are mainly used in aircrafts, space, satellite and mobile communications.

In patch antennas, characteristics such as high gain, beam scanning, or steering [3] capability are possible only when discrete patch elements are combined to form arrays. the elements of an array may be spacially distributed to form a linear, planar, or volume array. planar arrays have elements distributed on a plane. planar array configurations are extensively used in both communication [2] and radar systems where a narrow pencil beam is required. individual elements can be positioned along a rectangular grid to form a planar array for better control of beam shape and position in space. planar arrays of printed radiating elements are potentially good candidates for low cost scanning array applications. microstrip patch arrays are versatile as they can be used to synthesize a required pattern that cannot be achieved with a single element. in addition, they are used to increase the directivity [4] and perform various other functions, which would be difficult with any one single element.

Configurations of a symmetrical 3x3 and asymmetrical 2x4 patch array have been analyzed and an optimum frequency range of the patch antenna array has been arrived at. it is inferred that for any planar array configuration, optimized antenna characteristics can be obtained, depending upon element spacing. the effects of surface waves and mutual coupling can be minimized by optimizing the inter element spacing in both the planes. the antenna provides frequency close to the designed operating frequency with an acceptable directivity and gain. when antenna

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structure is closely spaced, the returns loss improves in E plane.it has been shown that with the increasing array spacing,the gain of the antenna gets reduced significantly.

THE MAJOR ADVANTAGES OF ANTENNA ARRAYS ARE:

- Increase the overall gain.
- Provide diversity reception.
- Cancel out interference from a particular set of directions.

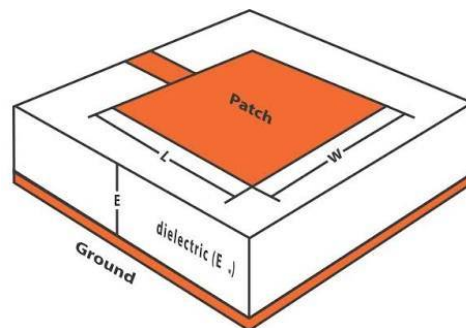


Fig.1: Three dimensional view of single patch antenna

The above figure shows the schematic view of single patch antenna.it consists of a patch element,ground plane and dielectric.the patch element is feed by using coaxial cable.width(w) and length(l) of patch are used for increase of decrease the antenna parameters.

II. PROPOSED ANTENNA DESIGN

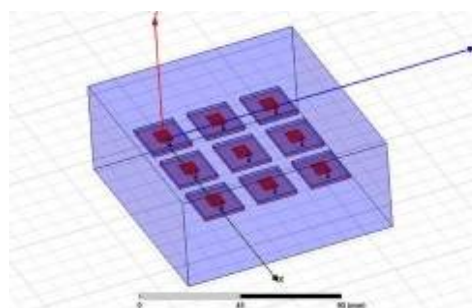


Fig.2:Rectangular patch antenna array

The configuration of above suggested rectangular patch antenna is shown in Fig.1.The fundamental shape of the patch antenna array as shown in Fig.2.

The frequency of operation of this patch antenna array is 2.4ghz. The patch antenna basically consists of three layers. The upper layer is a metal layer, middle layer is a substrate layer and the lower layer is the ground plane with the below mentioned dimensions. The length of rectangular metal layer of patch antenna is 26mm and width is 35.5mm. The length of rectangular ground plane of patch antenna is 71mm and width is 52mm having broadness about 5.75mm.Here the substrate used is air having the dielectric value as one. The number of patch elements increases the directivity of patch antenna increases.

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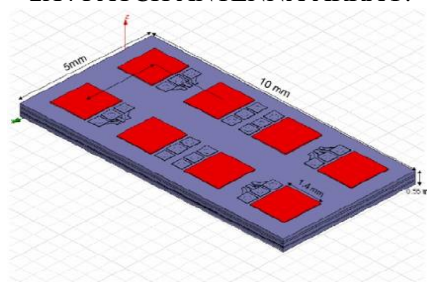
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TABLE 1

SPECIFICATIONS OF THE PATCH ANTENNA

SPECIFICATIONS	UNITS(Mm)
Length of the rectangular patch	26
Width of the rectangular patch	35.5
Height of the substrate	5.75
Distance	13.5
Frequency	2.4

2X4 PATCH ANTENNA ARRAY:



The above figure shows the schematic of 2×4 patch antenna array.in this design, it consists of 2 rows and 4 columns of patch antenna elements.

TABLE 2

SPECIFICATIONS OF THE PATCH ANTENNA

SPECIFICATIONS	UNITS
Radiated power(W)	0.0611568
Frequency(GHz)	2.4
Antenna efficiency(%)	76.446
Gain(dB)	15.9317
Directivity(dB)	17.0981
3 dB beam width(deg)	(8.10355,81.3166)
Incident poer(W)	0.08
Input power(W)	0.0657195
Average radiated power(W/S)	0.0048667

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Radiated efficiency(%)	73.0573
Radiated efficiency in upper space(%)	89.0573
Radiated efficiency in lower space(%)	3.54159e-009

III. DESIGN CONFIGURATION

Width of Patch antenna is given by

$$w = \frac{c}{2f_0 \sqrt{\frac{\epsilon_r + 1}{2}}}$$

Where c is the velocity of light and ϵ_r is the value of dielectric constant. Here $\epsilon_r=1$

Length of patch antenna is given by

$$\Delta L = (0.412 * h) \times \frac{(\epsilon_{reff} + 0.3) \times \left(\frac{w}{h} + 0.264\right)}{(\epsilon_{reff} - 0.258) \times \left(\frac{w}{h} + 0.813\right)}$$

The resonant frequency for any mode is given by

$$f_0 = \frac{c}{2\sqrt{\epsilon_{reff}} \left[\left(\frac{m}{l}\right)^2 + \left(\frac{n}{w}\right)^2 \right]^{1/2}}$$

The Directivity of the patch antenna is given by

$$D = \frac{\frac{1}{2} \text{Re}(E_\theta H'_\phi - E_\phi H'_\theta)(\theta = 0)}{P_{rad}/4\pi}$$

Coaxial-probe feeding technique is one of the most flexible and commonly using technique for patch antenna because the feed can be located at any desired location in patch in order to match with its input impedance. Here the feed diameter is given as 0.5mm.

IV. SIMULATION RESULTS

The proposed antenna is simulated using MATLAB software package. According to the simulated results the patch antenna array technique increases the directivity of antenna. The more the number of elements increases the directivity of antenna increases.

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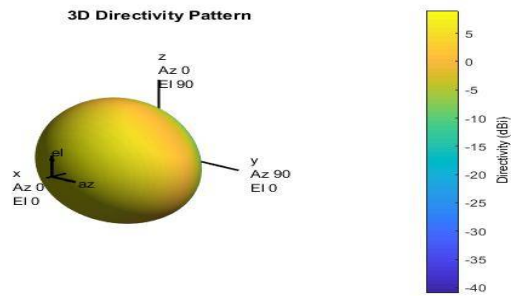


Fig.4:3D Directivity Pattern of Rectangular Array

The directivity pattern of rectangular arrays have the isometric radiation pattern .i.e; the radiation is same in all directions. We need pencil beam radiation pattern for wireless applications ,so that we need to increase the directivity of the antenna.for that purpose we need to design arrays.here we taken 2×4 and 3×3 patch antenna arrays.

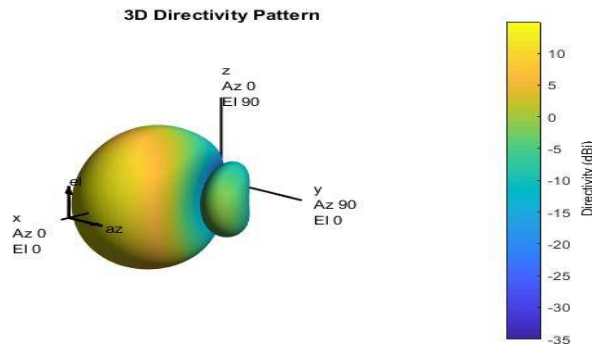


Fig.5: 3D Directivity pattern of 2x4 patch antenna array

The fig 5.3 shows the directivity pattern of the 2×4 patch antenna array.in this we observed that the radiation pattern contains one major lobe and one back lob. Here we somewhat increased the directivity of the antenna array.

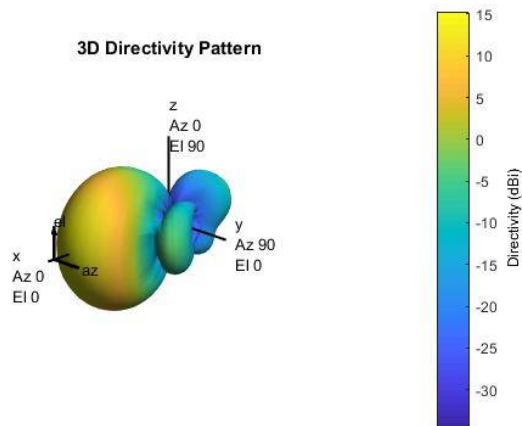


Fig.6: 3D Directivity pattern of 3x3 patch antenna array

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The above fig. Shows the directivity pattern of the 3x3 patch antenna array. From the fig. We observed that it contains major lobe, side lobes and back lobe. So that we are increased the directivity of the antenna array.

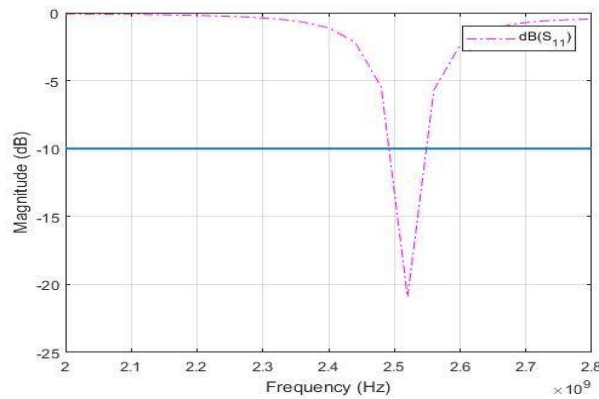


Fig.7: Reflection coefficient graph of patch antenna array

The above fig. Gives the graph between magnitude in db and frequency in Hz. So that we can easily analyze the characteristics of antenna array

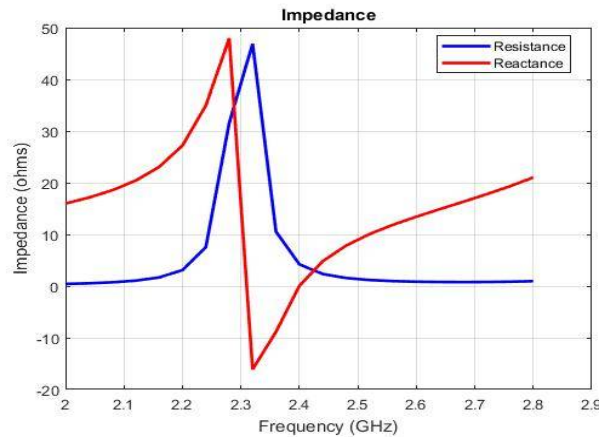


Fig.8: Impedance behaviour of patch antenna array

The above figure gives the graph between impedance in ohms and frequency in Ghz. So that we easily analyze the impedance characteristics of antenna array.

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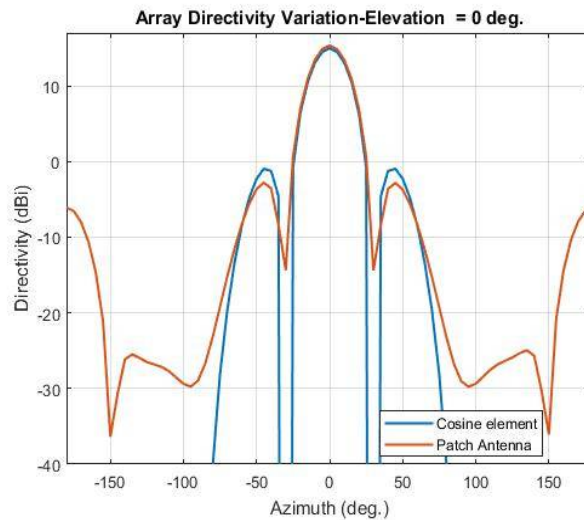


Fig.9: Radiation pattern along elevation direction

The above figure gives the graph between directivity in db and azimuth angle in degree. From the graph we observed that the directivity is increased.

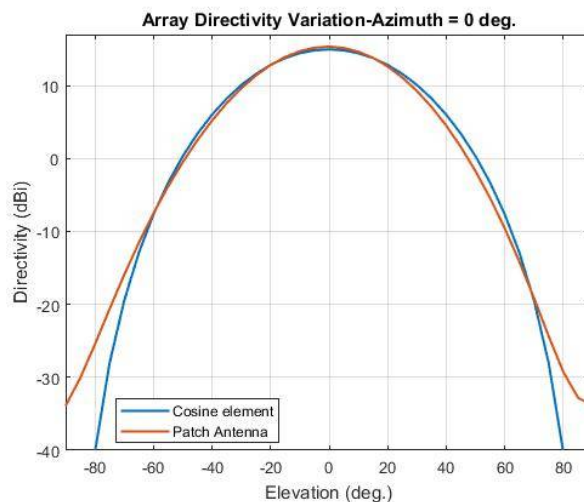


Fig.10: Radiation pattern along azimuth direction

The above figure gives the graph between directivity in db and elevation angle in degree. From the graph we conclude that the directivity was increased.

V. CONCLUSION

In this paper, patch antenna array is designed and is simulated using MATLAB software. The simulated results have increases Directivity and have the attractive features like light weight, low profile and portability. Not only increases the Directivity but also the parameters like pencil beam radiation pattern, bandwidth gets improved by using patch antenna array. But we are manly concentrating on Directivity parameter. Analysis of this antenna has been carried out on the basic of the antenna with array configuration. Simulated results of proposed antenna are suitable for communication purpose.

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