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Analyzing the Binomial Distribution for Linear Array of 5-Element Rectangular Microstrip Patch Antenna

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Abstract: *Currently there is a prompt development in the field of wireless communication applications. The effectiveness of the wireless devices can be determined by the layout of the antenna. Nowadays Microstrip patch antenna are used everywhere because it can be impressed straightly to a circuit board. These antennas are more attractive due to low cost, fabrication is easy, and it has a squat profile. This paper presents the designed and analysis of linear array of 5- Element rectangular Microstrip patch antennas and this has been simulated using a FEKO at 10 GHz to increase the gain and reduces the side lobes. The 5-Element linear array is considered and examined the impedance, gain, current magnitude, amplitude, power and sidelobes using binomial distribution. The elements are located regular at the interval of λ/2. The analyses are observed and the observations are plotted in graph. For 5-Element rectangular Microstrip patch antenna no sidelobes are observed and this antenna is used for different application such as satellite communication etc.*

Key words: *Microstrip antenna, Binomial Distribution, FEKO, Sidelobes, Impedance, Current magnitude.*

Introduction:

Nowadays, Microstrip antenna easily fabricated on printed circuit board and easily installed due to low size, weight and cost. Microstrip antenna having metallic patch placed on dielectric material and supported by ground plane. The proposed concept of Microstrip antennas to transmit radio frequency signals. The primary limitation of this type of antenna is the bandwidth is less than 5% for most single substrate design. The size of Microstrip antenna is inversely proportional to its frequency Microstrip patch. There are two categories of feeding method one category is contacting type and other category is non-contacting type. Contacting type is of two types one is line feed and other one is probe feed. Line feed simply a conducting strip usually of much smaller width compared to the patch. Probe feed simply an inner conductor of the coax is attached to radiation patch while the outer conductor is connected to the ground plane.

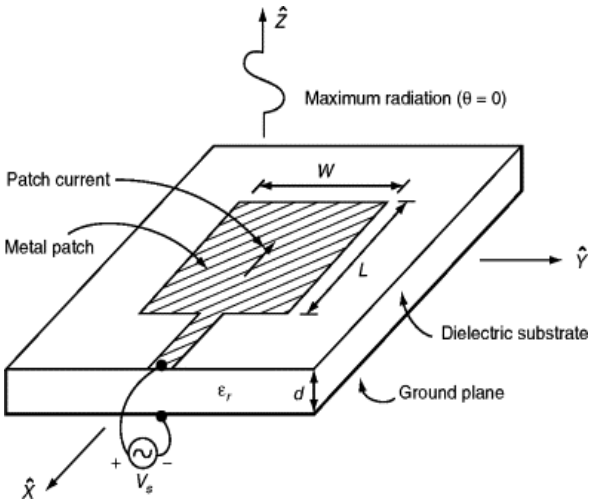

Fig 1 : Rectangular Microstrip Patch Antenna

Due to asymmetries in Microstrip line feed and probe feed. These feed generates higher order modes which produce cross polarized radiation. To overcome this problem non contacting types are used. Non contacting type consists of two types one is aperture coupling and other one is proximity coupling. The aperture coupling consist of two substrates separated by a ground plane and other one is proximity coupling enable us to excite the antenna while avoiding a direct connection between the feed and the patch. The most popular type of Microstrip antennas is rectangular Microstrip antenna. It is simplest and most widely used configuration for fabrication of Microstrip antennas. The Microstrip transmission line and the ground plane are made of a high conductivity metal.

Microstrip antennas generally have a very wide beam width, both in azimuth and elevation. In view of the cavity model of a Microstrip antenna, the simplest expression for directivity can be written as

$$D = \frac{2hE02w2k02}{pr\pi\eta 0}$$

Gain of a rectangular Microstrip patch antenna with air dielectric is roughly estimated between 7-9 Db in view of the following counts.

$$BW = \frac{S-1}{Q0\sqrt{S}}$$

Research Method

The most important parameter for the design of rectangular Microstrip antenna is the frequency of operation. In this paper, the operation frequency is 10 GHz for the design of rectangular Microstrip patch antenna using binomial distribution. Then the power, amplitude , gain, sidelobes, impedance and current magnitude are evaluated.

Linear array of 5-Elements rectangular Microstrip patch antenna are used to design the dielectric substrate, dielectric material and the dimensions of single patch antenna at the frequency is 10 GHz. The linear array of 5-Element rectangular Microstrip patch antenna has been designed and simulated by using FEKO Software. The 6-Element linear array is replaced by single element to 5-Element array to reduce the value of side lobes.

Linear array antenna consisting of a large number of short conductors connected in series. These elements arranged along straight line. Linear antenna of the array are uniformly spaced. It consist of N-Element array with uniform amplitude and spacing.5-Element array can be expressed as

$$E5 = M5\ En5\ (\theta, \emptyset)\ e^{-j\frac{kr5-\beta/2}{r5}}\rho 5$$

The array element is identical

$$En1\ (\theta, \emptyset) = En2\ (\theta, \emptyset) = En5\ (\theta, \emptyset) = En(\theta, \emptyset)$$

Result and Discussion:

In this proposed paper, a linear array of 5 - Elements rectangular Microstrip patch antenna has been designed and simulated by using FEKO software. The measurement of current magnitude, impedance, amplitude distribution, power in terms of gain for 5 element array using binomial distribution are listed in below table 1.

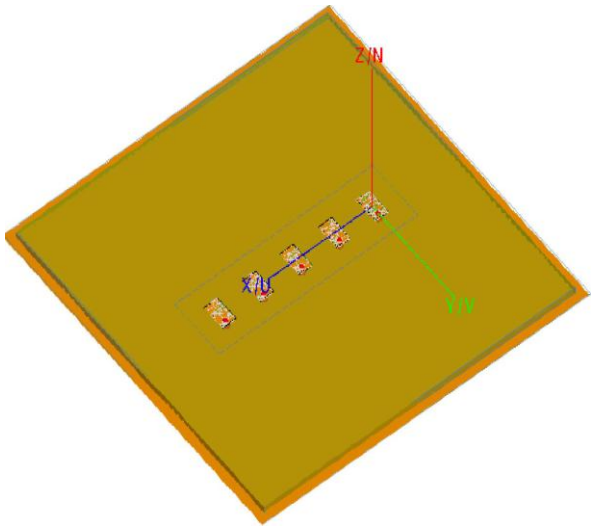

Fig 2: Shows the structure of 5 element lambda/2 spaced patch antenna array

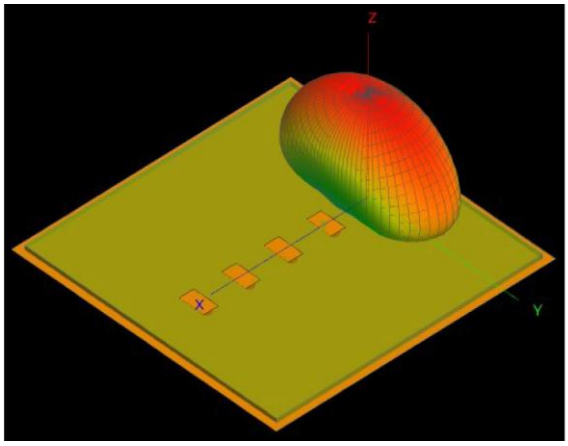

Fig 3: Shows the 3D radiation pattern a binomial amplitude distribution of 5- Element patch antenna array.

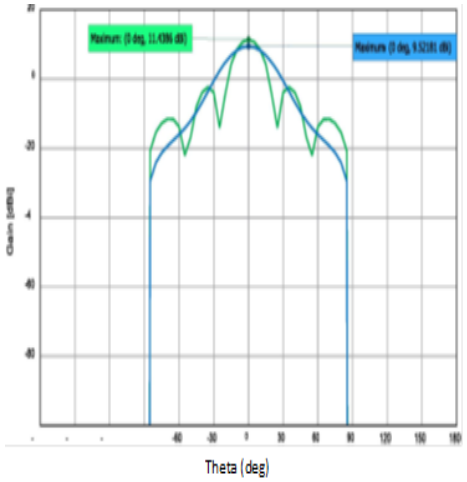

Fig 4: Shows the plot between the Total Gain vs phase(Frequency = 10 GHz; Phi = 0 deg) of 5 element array

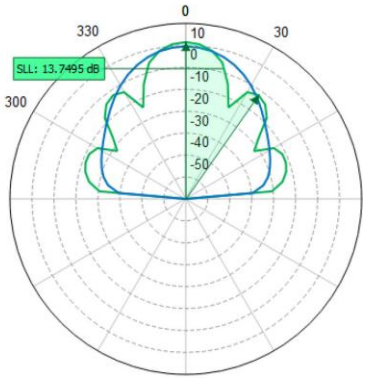

Fig 5: Side lobe level of the 5 element array shows the Far Field region having the sidelobes between total Gain vs phase in deg (Frequency = 10 GHz; Phi = 0 deg)

In the above figure green line shows uniform linear array side lobe, blue line shows binomial distribution has no side lobes. The patch antenna array of 5-Element was constructed using the binomial distribution and simulated and the following results were recorded.

Table 1: 5-Element Binomial Array Distribution Measurement Parameters

S.no	Parameters	Measurement values
1.	Binomial – Current Magnitude In A	2.08E-02
2.	Binomial – Impedance In ohm	2.40E+01
3.	Gain in dB (binomial distribution)	10.4929
4.	Side lobe level in dB	No Side Lobes
5.	Amplitude Distribution(Binomial - Amplitude)	0.8333
6.	Binomial Power In Watt	1.42E-03

Table 2: Power of Binomial Distribution For 5- Elements Linear Array

	Voltage source 1	Voltage source 2	Voltage source 3	Voltage source 4	Voltage source 5
Binomial power in Watt	1.42E-03	3.03E-02	1.03E-01	3.02E-02	1.42E-03

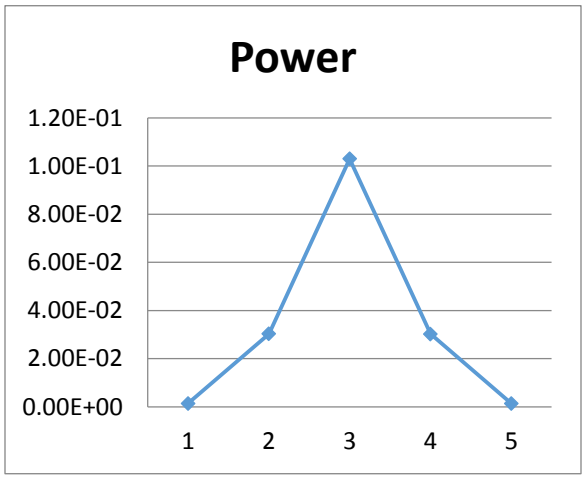

Chart 1: Power of Binomial Distribution For 5- Elements Linear Array

	Voltage source 1	Voltage source 2	Voltage source 3	Voltage source 4	Voltage source 5
Binomial current magnitude	2.08E-02	1.06E-01	2.13E-01	1.06E-01	2.08E-02

Table 3 : Current Magnitude of Binomial Distribution For 5 -Elements Linear Array

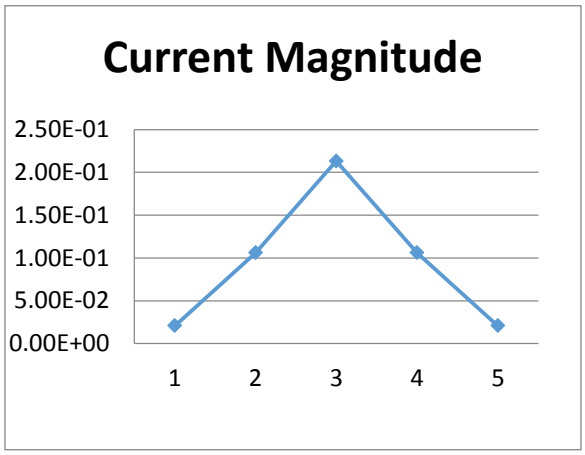

Chart 2 : Current Magnitude of Binomial Distribution For 5-Elements Linear Array

Table 4 : Impedances of Binomial Distribution For 5 -Elements Linear Array

	Voltage source 1	Voltage source 2	Voltage source 3	Voltage source 4	Voltage source 5
Binomial Impedances	2.40E+01	2.35E+01	2.35E+01	2.35E+01	2.40E+01

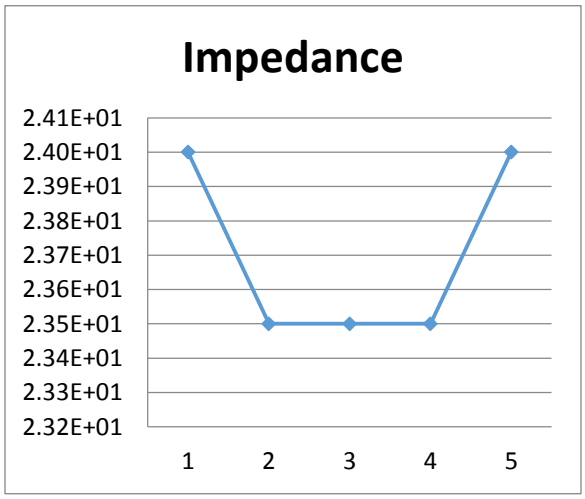

Chart 3 : Impedances of Binomial Distribution For 5 -Elements Linear Array

Conclusion:

The binomial distribution reduces the gain but it has no side lobes for 5-Element array. As the number of array elements will increases, the gain difference also increases. The binomial distribution also introduces a significant amount of difference in the amplitude of array elements. By using the proper tightening of the binomial distribution we can increase the gain as much as possible. With the simulation, the high gain 10.4929 dB and bandwidth of 5 GHz have been obtained. The obtained power is about 7.86E-02, a uniform-based array of 5-elements rectangular micro strip patch antenna. The binomial current magnitude of about 1.77E-01 in Ampere and binomial impedance of 2.40E+01 ohm. Also amplitude distribution of 0.8333 have been obtained.

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