Design of Shaped Beam Linear Aarray of Aperture Coupled Microstrip Antenna by Orthogonal Method with Far Field Mutual Coupling

AlothLaxman
Student, Department of ECE(Microwave Rader Engineering),University college of Engineering,Osmania University,TS,India

ABSTRACT— Orthogonal method has been used to synthesis of linear array antenna with Aperture Coupled Microstrip Antenna (ACMA) elements to obtain a shaped beam radiation pattern. The ACMA has been used as the array element because of its wide bandwidth return loss. Also, to achieve the correct excitation for the array elements, mutual coupling between them has been considered in the synthesis procedure. The mutual coupling effect has been shown by comparing the simulation results with and without of this effect in the orthogonal synthesis procedure. Finally, based on the optimum results of the orthogonal synthesis method a suitable feeding network has been designed for the array.

INTRODUCTION

Because of the advantages of array antennas these configurations are used for beam forming problems in communication systems [1]. Different methods have been used for synthesis and optimization of the array antennas. Many parameters should be considered in the synthesis of the array antennas. One of the most important of these parameters is mutual coupling between thearray elements [2]. Different methods have been applied to compensate the mutual coupling by calculating the coupling coefficients such as Fourier decomposition and so on. In the synthesis of the array antennas the processing time and accurate results are so important. The orthogonal method that is extended and generalized for the synthesis of the array antennas can be used to obtain the excitation of the array elements with considering the mutual coupling to achieve the desired radiation pattern [3]. In the present work, to consider the mutual coupling the E Field radiation pattern of each element in the presence of the other elements (Active P has been obtained from HFSS the active radiation patterns are used to synthesis the array by the orthogonal method to obtain the desired radiation patternthis case to compensate the mutual coupling effect and to correct the excitation of the elements, it is necessary to calculate the coupling coefficients matrix K. The orthogonal method is used to derive the coupling coefficient between the elements. To calculate this coupling coefficient it is necessary to measure or calculate the radiation pattern of each element fθ, ϕ. In this work, this function is derived by HFSS simulator. By determining the coupling coefficients, compensated excitation coefficients to create the desired radiation pattern can be derived as [5]:return loss and gain of ACMA will obtain. The antenna is designed by PCB microwave board

ORTHOGONAL

Orthogonal method is the technique that use the orthogonally between functions and obtain the excitation of array elements. If the mutual coupling between the elements will not be considered, derivation of the excitation is a simple procedure [3]. To this end, the array factor has the following formthe position of each element. ϕθ, ϕare the non-orthogonal independent functions. Based on the gramSchmidt theorem [4], ϕθ, ϕ can be used to construct the orthonormalized basis functions Ψθ, ϕas:For the isolated array elements, the array factor is defined as (6). In which I is the excitation coefficient of nth element when mutual coupling is not taken to account and f θ, ϕis the isolated radiation pattern of the elements. The excitation coefficients will be determined based on the orthogonal method procedure in the previous section, to shape the AF in a desired form.

In this case to compensate the mutual coupling effect and to correct the excitation of the elements, it is necessary to calculate the coupling coefficients matrix K. The orthogonal method is used to derive the coupling coefficient between the elements. To calculate this coupling coefficient it is necessary to measure or calculate the radiation pattern of each element fθ, ϕ. In this work, this function is derived by HFSS simulator. By determining the coupling coefficients, compensated excitation coefficients to create the desired radiation pattern can be derived as [5]:

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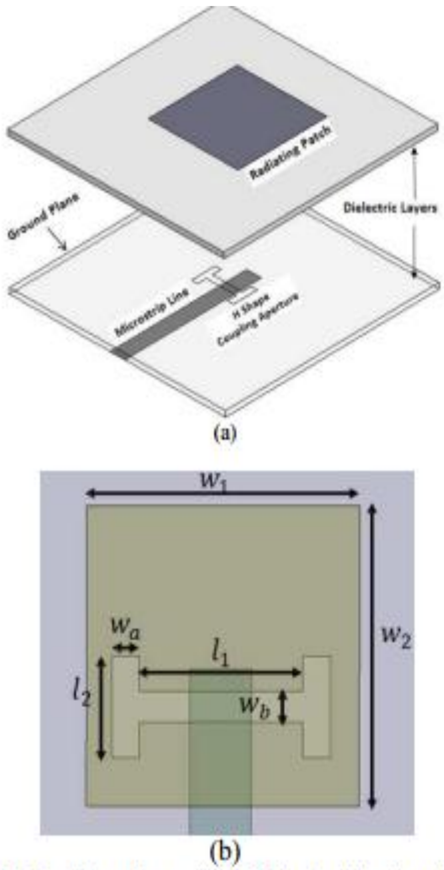


Fig. 1 Configuration of ACMA a) side view b) top view $l_1 = 4.8mm, l_2 = 2.7mm, w_1 = w_2 = 8mm, w_a = w_b = 0.8mm$

The 10dB return loss bandwidth of the antenna is about 21% and has been depicted in Fig. 2. Also, the gain of the antenna has been shown in Fig. 3this case to compensate the mutual coupling effect and to correct the excitation of the elements, it is necessary to calculate the coupling coefficients matrix K. The orthogonal method is used to derive the coupling coefficient between the elements. To calculate this coupling coefficient it is necessary to measure or calculate the radiation pattern of each element fθ, ϕ. In this work, this function is derived by HFSS simulator. By determining the coupling coefficients, compensated excitation coefficients to create the desired radiation pattern can be derived as [5]:return loss and gain of ACMA will obtain. The antenna is designed by PCB microwave board

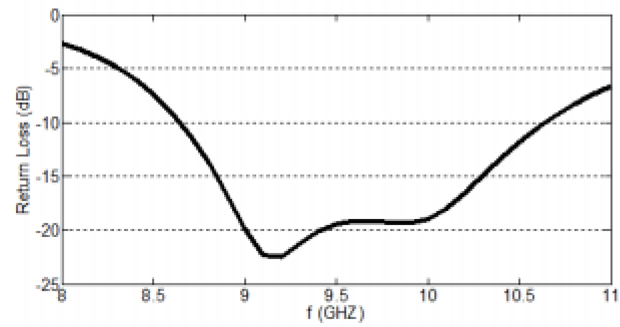


Fig. 2 Return Loss of single element

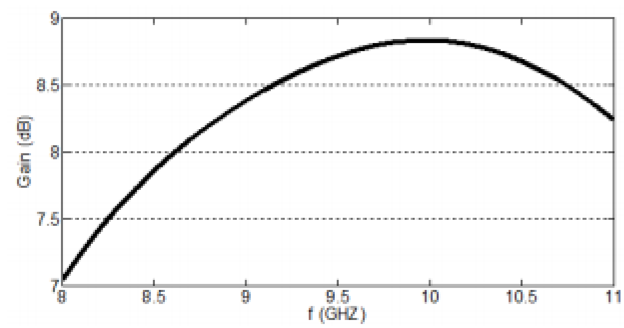


Fig. 3 Gain of single element

Array structure The linear array antenna configuration (Fig. 4) that has been studied in this paper consists of 8 elements with d=0.76λ at the center frequency 9.5GHZ

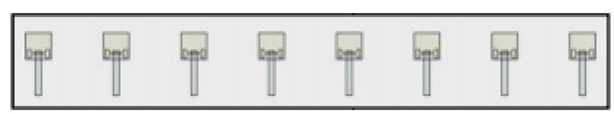
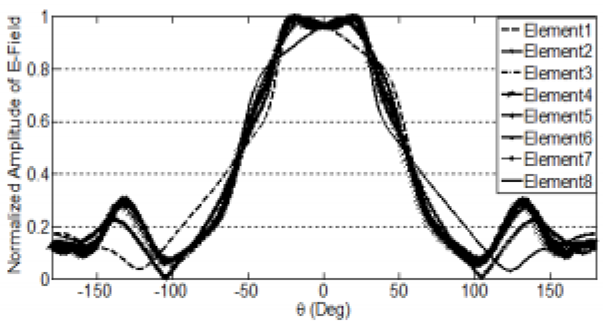


Fig. 4 Aperture coupled microstrip array antenna

Based on the synthesis procedure mentioned in the section II, the array antenna in the Fig. 4 are studied in this section. At first the array are studied without consideration of mutual coupling and then the effect of mutual coupling is considered based on the equations (7-10). In the presence of mutual coupling, the amplitudes and phases of E patterns of the elements are different and depicted in Fig. 5.this case to compensate the mutual coupling effect and to correct the excitation of the elements, it is necessary to calculate the coupling coefficients matrix K. The orthogonal method is used to derive the coupling coefficient between the elements. To calculate this coupling coefficient it is necessary to measure or calculate the radiation pattern of each element fθ, ϕ. In this work, this function is derived by HFSS simulator. By determining the coupling coefficients, compensated excitation coefficients to create the desired radiation pattern can be derived as [5]:return loss and gain of ACMA will obtain. The antenna is designed by PCB microwave boardOrthogonal method is the technique that use the orthogonally between functions and obtain the excitation of array elements. If the mutual coupling between the elements will not be considered, derivation of the excitation is a simple procedure [3]



CONCLUSION

Orthogonal method is the technique that use the orthogonally between functions and obtain the excitation of array elements. If the mutual coupling between the elements will not be considered, derivation of the excitation is a simple procedure [3]In this paper this case to compensate the mutual coupling effect and to correct the excitation of the elements, it is necessary to calculate the coupling coefficients matrix K. The orthogonal method is used to derive the coupling coefficient between the elements. To calculate this coupling coefficient it is necessary to measure or calculate the radiation pattern of each element fθ, ϕ. In this work, this function is derived by HFSS simulator. By determining the coupling coefficients, compensated excitation coefficients to create the desired radiation pattern can be derived as [5]:return loss and gain of ACMA will obtain. The antenna is designed by PCB microwave board the excitation coefficients of the linear array antenna with ACMA elements has been synthesized using orthogonal method by considering the mutual coupling effect between the array elements. The orthogonal method is the accurate and fast method to synthesize of the array antennas to obtain the desired shaped beam radiation pattern.

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