

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

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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.

KEYWORDS: orthogonal method; mutual coupling; aperture coupled microstrip antenna; array antenna

I. 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 the The Second Iranian Conference on Engineering Electromagnetics (ICEEM 2014), Jan. 8-9, 2014 606 This paper is authentic if it can be found in www.isseem.ir. Design of Shaped Beam Linear Array of Aperture Coupled Microstrip Antenna by Orthogonal Method with Far Field Mutual Coupling , A. Pirhadi¹ , M. Akbari ^{2*}, N. Rojhani ² , and M. Saberi Electrical Engineering, University of ShahidBeheshti, Young Researchers and Elite club, Central Tehran Branch, Islamic Azad University, Tehran, Iran. Corresponding author: akbari.telecom@gmail.com 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 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 antenna. Because of the advantages of array antennas these configurations are used for beam forming problems in communication systems

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[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 pattern.

II. 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 form: An antenna both transmitting and receiving the information so it is the essential part of the microwave communication. It is a device that is made to efficiently radiate and receive the radiated electromagnetic waves. Antenna is a transducer which converts the voltage and current on a transmission line into an electromagnetic field in a space, consisting of an electric and magnetic field travelling right angles at each other [1,2,3].

Generally, to detect the cancerous tissue, the microwave imaging system is made by a circular cylindrical array antenna microwave imaging systems need little antennas with omni-directional radiation patterns and enormous information measure. Thus, in microwave imaging systems, over the full operative band one of key issues is that the style of a compact antenna whereas providing wideband characteristic. It is a well-known incontrovertible fact that placoid monopole antennas physical options, like easy structure, little size and low price present very appealing [2-4]. Consequently, variety of planner monopoles with totally different geometrics are through an automatic style strategies and experiment

characterized have been developed to attain the optimum placoid form [5]. With the event of band wireless communication systems, ultra wide band (UWB) systems have been increasing quickly.

The Federal communications Commission allotted the wave band 3.1~10.6 GHz for the UWB services. These UWB systems have been used for radiolocation applications, localization, information communications etc. The antennas of UWB systems area unit embedded into these transmission devices, the house networking system is wide utilized in transmission devices like HDTV's, DVD's, cameras and private computers through the UWB service channels [6]. The most commonly employed microstrip patch antenna is a rectangular patch. The rectangular patch antenna is approximately a one wavelength long section of rectangular microstrip transmission line. The antenna is loaded with a dielectric as its substrate, the length of the antenna decreases as the relative dielectric constant of the substrate increases. When the air is the antenna substrate the length of the rectangular microstrip antenna is approximately one half of a free space wavelength. The proper miniaturized antenna will improve the transmission and reception. Microstrip resonators will be classified into 2 sorts counting on the length and width of antennas. Resonators with a slim conductor known as microstrip dipole and resonators with a large conductor are referred to as microstrip patch. Resonance happens once the dipole or patch dimensions are of a half guided wavelength. Longitudinal current distribution here for their pattern and gain are similar, however the alternative properties (e.g. input electrical phenomenon and polarization) will vary. When the signal frequency is within the section of a resonance, a microstrip resonator radiate comparatively broad beam, broadside to the plane of the substrate. A serious part of the sign participates in radiation and so the resonator acts as an antenna. Since patch dimensions should be of the order of a radio-controlled wavelength, its directivity is extremely low

as an example, a half-wavelength dipole generally features a gain of regarding 5-6 Db and beam width between 70 and 90 degrees

The design of a microstrip antenna begins by deciding used for the antenna so the size of the patch. due to the fringing fields on the radiating edges of the antenna there's a line extension related to the patch. The basic structure of the microstrip patch antenna design is shown in fig.1.

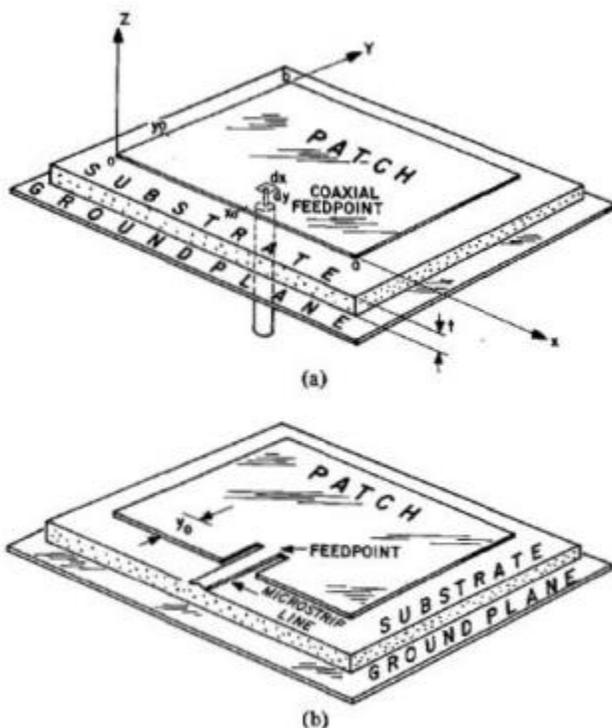


Fig. 1 The structure of microstrip antenna.

LITERATURE REVIEW

The construct of microstrip antenna with conducting patch on a ground plane separated by insulator substrate was undeveloped till the revolution in electronic circuit shrinking and large-scale integration in 1970. After that several mortal have drawn the radiation from very cheap plane by a insulator substrate for numerous configurations. Various mathematical analysis models were developed for this

antenna and its applications were extended to several numerous fields. The little strip antennas unit today antenna designer's selection. Throughout this section, the microstrip antenna literature survey is mentioned. "Nasser Ojaroudi" has proposed a compact with multi-resonance characteristics UWB/Omni-Directional Microstrip Monopole Antenna with multi-resonance characteristic has been projected for microwave imaging systems leads to compact antenna with smart omni-directional radiation characteristics for projected in operating frequencies. The fictious antenna satisfies the VSWR

saves time as compared to the design of patch antenna without optimization algorithm and also PSO restricts the variation from center frequency [4,6]. "JyotiRanjan Panda" has researched that A Compact Printed Monopole Antenna(PMA) for Dual-band RFID and WLAN Applications. From 9-shaped folded antenna, dual-band operation is achieved which is printed on a non-conductor backed dielectric. Impedance bandwidth 33.13% at 2.43 GHz and 36.43% at 2.43GHz is measured of the PMA. The proposed antenna exhibits broadband impedance matching, consistent omni directional radiation patterns and appropriate gain characteristics (>2.5 dBi) in the RFID and WLAN frequency regions [11]. "Mohammad Ojaroudi" has presented a novel, compact printed monopole antenna (PMA) for UWB applications. The fabricated antenna satisfies the 10-dB return loss requirement from 3.12 to 12.73 GHz.

The feed-gap distance, the sizes of Tshaped notch, and the sizes of two rectangular slots in the antenna's patch is used to obtain the wide bandwidth have been optimized by parametric analysis. This antenna exhibits good radiation behavior within the UWB frequency range. [12]. " Y. Chen", has proposed Design And Analysis Of Wideband Planar Monopole Antennas Using The Multilevel Fast Multipole Algorithm. In this to analyze the impedance bandwidth and radiation performance of the monopoles a full-wave method of

moment (MoM) based on the electric field integral equation (EFIE) is applied. Meanwhile, to reduce the memory requirements and computational time, the multilevel fast multipole algorithm (MLFMA) is employed. Two wideband planar monopoles attached to finite sized ground planes are designed, analyzed, and fabricated. Both of the simulated and measured results shows that the two monopoles are capable to cover the AMPS, GSM900, and DCS band. In the whole operating frequency, both of the monopoles can provide a nearly omni-directional radiation pattern in the azimuth plane [13]. "Nakchung Choi" has proposed a notch-frequency band for a UWB antenna which can be embedded into laptop computers with an I-shaped parasitic element. This novel band-notched UWB antenna has the capability to provide easy tuning of the notch-frequency function and bandwidth with good stop band rejection

Study of Antenna Designing Parameters

There are three essential parameters for design of a rectangular microstrip Patch Antenna. Firstly, the resonant frequency (f_0) of the antenna must be selected appropriately. The frequency range for ultra wide band applications is 3.1 to 10.6 GHz and the design antenna must be able to operate within this frequency range. The second important parameter of antenna is substrate thickness. The height of dielectric substrate (h) of the microstrip patch antenna with coaxial feed is to be used in S-band range frequencies. Hence, the height of dielectric substrate employed in this design of antenna is $h = 1.6\text{mm}$. The third important parameter of good antenna design is dielectric substrate (ϵ_r). A thick dielectric substrate having low dielectric constant is desirable. This provides better efficiency, larger bandwidth and better radiation. The low value of dielectric constant increases the fringing field at the patch periphery and thus increases the radiated power lower quality factor Q . FR-4 Epoxy which has a dielectric constant of 4.4 and loss tangent equal to 0.02 can be used for new

antenna design. The look of patch are going to be fed by a microstrip transmission line. Patch is act as a conductor. This structure of the antenna having length of patch L , width W , height of dielectric substrate h and Loss tangent. The dielectric constant of the substrate material is an important design parameter. These are placed on infinite ground plane. The length is formed around $Lg/2$, that the patch starts to radiate, that typically incorporates 50 Ohm impedance. The antenna is typically fed at the diverging edge on the dimension W because it offers sensible polarization, but the disadvantages area unit the spurious radiation and want for electric impedance matching this is often as a result of 150 to 300 typical edge resistance of a microstrip antenna ranges. The antenna parameters antenna can be calculated by the transmission line method [Balanis, 2005] and [4] as exemplified below:

Feed Location Design:

To radiate the antenna a feed is used to excite by direct or indirect contact. The feed of microstrip antenna can have many configurations like microstrip line, coaxial, aperture coupling and proximity coupling. But for fabricate easily microstrip line and the coaxial feeds are relatively used. Coaxial probe feed is used because it is easy to use and the input impedance of the coaxial cable in general is 50 ohm. There are several points on the patch which have 50 ohm impedance. We have to find out those points and match them with the input impedance. Feed point is chosen so that where at the point of radiating patch maximum area of patch is covered. By changing feeding points antenna is radiate at different radiating frequency. We will use coaxial probe feeding technique

Results and Analysis

Result and analysis of previous literature papers is given in literature review table given in below Literature Review Table:

Ref No.	Approach	Conclusion
1	Modified ground plane with pairs of L-shaped slits and parasitic structures	Bandwidth of more than 130% (2.95-14.27 GHz) radiation efficiency is greater than 86%
3	VSWR and Radiation Pattern	Return loss of -29.2133 dB at 1.8 GHz
5	Inverted U-shaped slots and two L-shaped parasitic elements	Bandwidth of more than 130% (2.9-14.3 GHz) & good omnidirectional radiation pattern
8	I-shaped slot on the feed-line and a pair of S-shaped slots in the ground plane	Wider impedance bandwidth & radiation efficiency is greater than 82%
12	Ground plane with inverted T-shaped notch	Bandwidth of more than 120% (3.12-12.73 GHz)
14	Half-wavelength parasitic element printed on the rear side of the substrate.	Impedance bandwidth of antenna is 3.1-11.4 GHz (114%)
15	Two monopoles of the same size and a small strip bar	Band notch mechanism of the antenna was examined with current distribution
16	Embedding a notch in the ground plane	Frequency band of 2.95 to 11.7 GHz with the stop band of 4.92 - 5.86 GHz.

Conclusion

This is a review paper shows that study of the Microstrip Patch Antenna using UWB frequency ranges for Wireless communication devices applications. After study of literature survey it is concluded that multi resonance characteristics of MPA such as Return loss, VSWR, Radiation pattern, impedance bandwidth can be improved by changing the parameters such as operating frequency, ground plane structure dimensions, feeding techniques. Can be made usable new structure defined MPA within UWB ranges for many wireless devices communication applications.

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