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Broadband Microstrip Yagi Array Antenna for S-C Band Application

Sudheer Dubey* and Sameena Zafar

Department of Electronics & Communication Patel Institute of Engineering & Science.

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ABSTRACT

This paper presents an optimum design technique of broadband two elements Yagi array antenna. The optimization parameter for the proposed antenna is the impedance bandwidth using appropriate dimensions of ground plane and in Yagi array, dipole is replace by patch, all element design in form patch. In this paper we observed effect with and without ground plane on impedance bandwidth. Appropriate Spacing is used between elements; all elements designed on scale of reflector, the proposed antenna can be used for C-Band application. For validation of proposed geometry IE3D Simulator is used.

Introduction

A Yagi-Uda array, commonly known simply as a Yagi Additional parasitic elements (usually a so-called *reflector* and one or more *directors*). The name stems from its inventors, as the Yagi-Uda array was invented in 1926 by Shintaro Uda of Tohoku Imperial University, Japan, with a lesser role played by his colleague Hidetsugu Yagi. However the "Yagi" name has become more familiar with the name of Uda often omitted. The reflector element is slightly longer (typically 5% longer) than the driven dipole, whereas the so-called directors are a little shorter. This design achieves a very substantial increase in the antenna's directionality and gain compared to a simple dipole [1]. In a small director array (SDA) is an antenna gain enhancing section of the low-profile smart antenna which can be used as a fixed array or reconfigurable array using switched parasitic elements [2], the design and construction of a microstrip Yagi array antenna operating at 5.3 GHz [2], to be used with an avalanche sensor in avalanche measurement. The advantage of the antenna is it can achieve a high gain of 15.2 dB with bandwidth of 8% in compact size. In this paper [4] an integrated Microstrip-fed quasi-Yagi antenna array for a different DSRC system is proposed. The antenna was fabricated on Rogers RO4003 substrate. The proposed antenna profile

Provides at 5.8 GHz: a measured return-loss of -16 dB. During the last two decades, many literatures have been published for the design and optimization of plane microstrip yagi antenna arrays [5{7]. In [5], multi-objective evolutionary algorithms (MOEAs) are used to optimize the yagi-antenna parameters to get specific antenna characteristics. A genetic algorithm is used in [6] for an optimum design of an asymmetric V-dipole antenna and it is a three-element Yagi-Uda array. In addition, in [7] a modified two-element Yagi-Uda antenna with tunable beams in the H-plane (including four significant beams: forward backward, omni-directional, and bidirectional beams) is presented. Recent papers have been presented [8, 9] for high gain yagi array antennas. In [9], two different long range yagi-Uda UHF RFID tag antennas have been designed and tested. The tag antenna size is reduced by using T-matching method. In [9], the effect of platform materials for high gain quasi-yagi plane antennas designed for mobile platform integration at 60 GHz is presented. High-gain compact stacked multilayered yagi antennas are proposed and demonstrated at 5.8 GHz for local positioning systems (LPS) applications [8].In the present work, analysis and design are carried out for a wide band yagi and bi-yagi microstrip antenna arrays. The ground plane of the array is etched to produce photonic band gap (PBG) structures [9, 10]. These PBG structures are used to eliminate required bandwidths at the higher end of the operating bandwidth and to increase the F/B ratio. A compact, high-gain antenna array with beam steerable capability into multiple directions is attractive for modern wireless systems. Previously, a closely spaced Yagi antenna [19] was designed to reduce the spacing between the array elements while maintaining high gain of array. The spacing between the array elements is .02λ. In that design, multiple folds are used to increase the reduced radiation resistance due to close spacing between array elements.

Proposed Antenna Design

A. Proposed antenna design without ground plane

B. Proposed antenna design with appropriate dimension of ground plane

A. Proposed antenna design without ground plane

In fig1, presented proposed antenna without ground plane. For design of proposed Yagi antenna mathematical analysis of conventional microstrip antenna is used, dimension of proposed antenna are

□ Length and width of reflector is

□ L_R = 17.78mm, W_R=20.32mm □

□ Length and width of driven element

□ L_D= 16mm, W_D= 18.288mm □

Length and width of First director

L_{Dir1}=14.22mm,W_{Dir1}=16.256mm □

The Proposed geometry design in IE3D Simulator at 4GHz center frequency, in first step design reflector by using theory of patch antenna, then design driven element. Driven element has .1λ times less width and length ratio compared to width to length ratio of reflector, similarly design directors.

Tele:

E-mail addresses: sudheerdubey_1988@yahoo.com

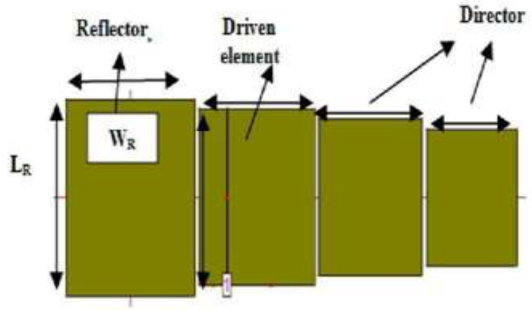

Figure 1 Proposed antenna without ground plane

In design of each successive elements have width to length ratio .1λ times less compared to width to length ratio of previous element. Spacing between all elements are .1λ, the design ratio.1λ is appropriate for obtaining broad bandwidth, in section result analyses without consideration the effect of ground plane, this section reported 20% impedance bandwidth from 3.5GHz to 4.5GHz. Obtained -20dB, return loss at 4GHz. VSWR and Return Loss depicts in fig 2 and in fig 3.

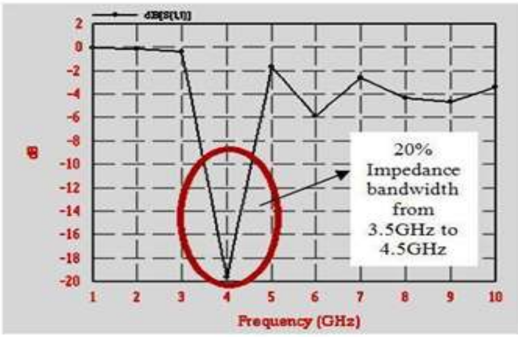

Figure 2 Return Loss Vs Frequency

Fig 2 represent return loss vs. frequency, at 4GHz return is - 20dB, and impedance bandwidth is 20% for band of frequency 3.5GHz to 4.5GHz, this result achieved without consideration of ground plane.

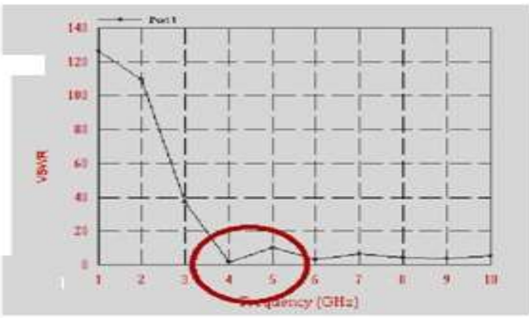

Figure 3 VSWR Vs Frequency

Proposed antenna design with Appropriate dimension of ground plane for further enhancement in bandwidth of proposed antenna appropriate dimension of ground is used ,fig 4 represent the geometry with ground plane in design

The radiation properties of antenna significantly improve due to effect of ground plane, achieved appropriated elimination of reflected signal, after validation in IE3D Simulator , achieved 40% bandwidth from 3.6GHz to 5.4GHz, at 4GHz obtain return loss up to -16dB, VSWR and return losses depicts in fig 5 and fig 6. Elevation and Azimuth pattern analyses in fig 7 and fig 8, Table –I demonstrate comparison in geometries with respect to with ground plane and without ground plane, applied input signal, radiated power, Directivity, 3dB, Beam width and impedance bandwidth all shown in Table-I.

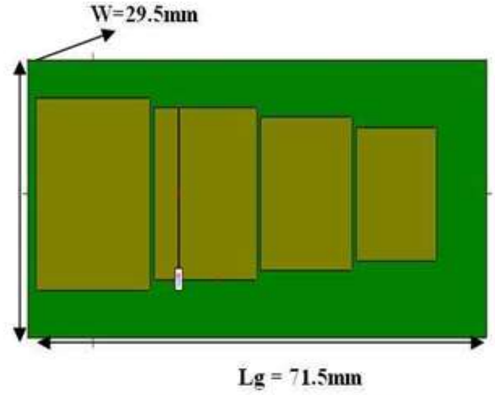

Figure 4 Proposed antenna with ground plane

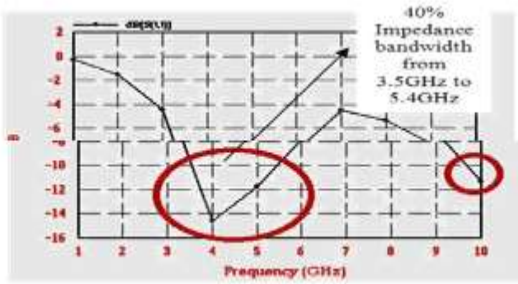

Figure 5 return loss vs frequency

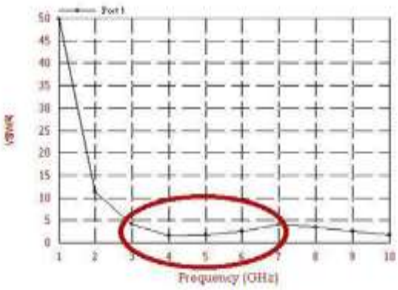

Figure 6 VSWR Vs frequency

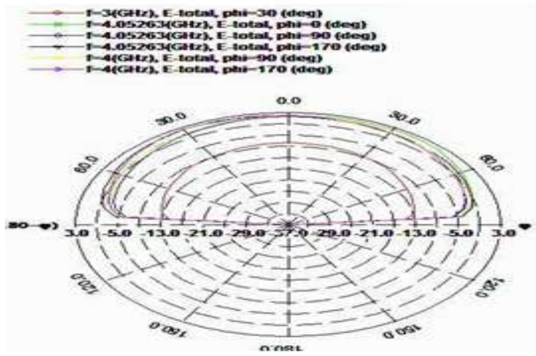

Figure 7 elevation pattern at 4GHz

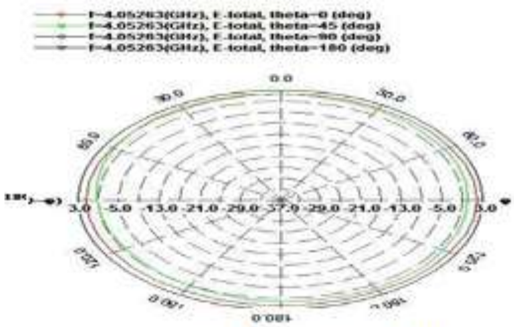

Figure 8 Azimuth pattern at 4GHz

Table-I Results summary of proposed gemetries at 4GHz

Parameters	Proposed Design With ground plane	Proposed Design Without ground plane
Input power	0.00960774 (W)	0.00960774 (W)
Radiated Power	0.00423736 (W)	0.00425248 (W)
VSWR≤2 Impedance Bandwidth	40% at center frequency 4GHz	20% at center frequency 4GHz
3D Beam width	(72.3103, 139.467) deg	(62.5395, 143.012) deg
Directivity	6.04864 dBi	6.06744 dBi

Result And Discussion

Fig 2 and fig 5 depicts the effect of ground on geometry in fig 2 obtain 20% bandwidth but in fig 5 obtain 40% bandwidth,.1λ scale of reflector with combination of patches for reflector ,driven element and directors is good arrangement for bandwidth enhancement . Fig 7 and fig 8 represents radiation pattern, in fig 6 depicts VSWR, with respect to appropriate arrangement of ground plane we achieved improvement in bandwidth.

Conclusion

We analyzed proposed geometry with and without ground plane and found appropriate geometry. We concluded that .1λ scale of reflector is appropriate method for bandwidth enhancement, from validation of proposed geometry, concluded that ground plane is effective role for bandwidth enhancement, and achieved 40% impedance bandwidth for operating frequency 3.4GHz to 5.6GHz, The main applications of design and optimization of yagi array antenna for wireless communication, satellite communication at S-C-X Band application

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