# A Quasi-Yagi Microstrip Antenna with Simplified Feeding Structure


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***Abstract*— In this paper, a Quasi-Yagi antenna with a simplified feeding network is proposed. The impedance bandwidth, radiation patterns and gain of the proposed antenna are studied by the Finite Difference Time Domain (FDTD) method. The simulated and measured results show that the accomplished bandwidth of the antenna can cover a frequency range from 4.64 GHz to 6.25 GHz, which involves the two WLAN bands of 5.15 GHz to 5.25 GHz and 5.75 GHz to 5.85 GHz. Within the frequency band, the radiation characteristic of the antenna exhibits a good performance, and the maximum gain is about 7.2 dB. The antenna is easy to integrate with the microwave circuits and other solid devices.**


## I. INTRODUCTION

Recently, planar Quasi-Yagi antenna received more interesting due to its suitability in a wide range of applications, such as the wireless communication systems, space power combining systems, phased arrays, active arrays, and millimetre wave imaging arrays. The traditional Quasi-Yagi antenna consists of one driving element, one reflector, and one or more directors [1]. This kind of antenna is lightweight, low cost and easy to fabricate. Instead of driven directly, the reflector and directors are working as parasitical elements, and are coupled with the driver. It is well known that the Quasi-Yagi antenna can achieve relatively higher gain with low cost [2], and is primarily used in the area where end-fire radiation property is desired. From antenna theory we know, to realize the end-fire radiation property, appropriate amplitude and phase distributions along the strongly coupled reflector, driven element, and the directors must be satisfied.

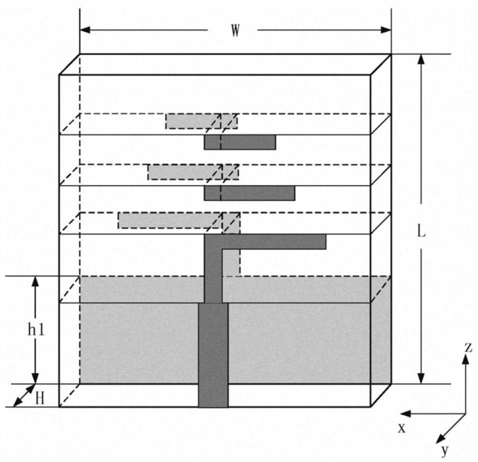
Various designs of the Quasi-Yagi microstrip antennas can be found in the literatures [3-7]. In these designs, similar drivers and director elements are employed, but the feeding mechanisms are different. Typical feeding structures among these designs include the microstrip feeding and coplanar waveguide (CPW) feeding. Usually, baluns are required in these kinds of feeding structures for transforming the transmission line mode of the antenna to the CPW mode of the coplanar stripline. The drawback of these kinds of designs is the relatively complicated baluns used in the feeding structures. These baluns not only increase the size of the structure, but also degrade the radiation performance of the antenna. In addition, baluns with narrowband property used in the design of wideband antenna may excite unbalanced feeding current outside its bandwidth, and therefore, limit the bandwidth and radiating property of the whole antenna.

In this paper, an alternative design of a simplified feeding network is proposed, which naturally overcomes the shortcoming of balun. The feeding network consists of the microstrip line and stripline. With the use of microstrip line, it is easier to adjust the size of the antenna, and the fabricating difficulty and processing cost are also greatly reduced.

## II. ANTENNA DESIGN

### *A Antenna Structure*

A schematic of the proposed antenna is shown in Fig. 1. As can be seen from the figure, the antenna consists of two director elements and one driven element, a ground plane is acting as the reflector. The antenna is printed on a 1.6 mm thick dielectric substrate with $\varepsilon_r$ = 4.4 (FR4). The feeding structure consists of a microstrip line and a segment of stripline [8]. There is no balun used in the structure for balance-unbalance transforming and impedance matching. The microstrip line is carefully designed with the characteristic impedance of 50 Ω. The truncated ground plane on the other side of the dielectric acts as the reflector. The length of the stripline is about quarter wavelengths.




(a) 3D schematic diagram

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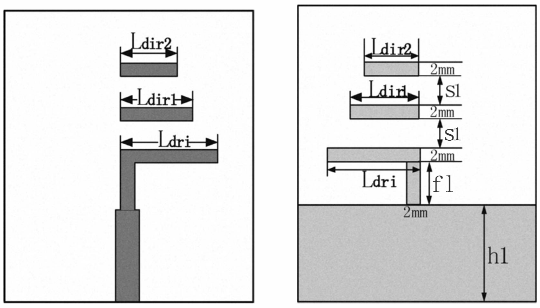


(b) Top layer (c) Bottom layer

Fig. 1 Geometry of the antenna

## B Parametric Study

Using this structure, the initial parameters can be chosen very easily, the length of the driven element should around 0.5 $\lambda_g$, the length of the directors should about 0.45 $\lambda_g$ according to the principle of Quasi-Yagi antenna [2]. Here, $\lambda_g$ refers the longest effective wavelength of the antenna. It is calculated by expression (1).

$$\lambda_g = \frac{\sqrt{2}c}{f\sqrt{\varepsilon_r + 1}} \tag{1}$$

where $\varepsilon_r$ is the dielectric constant of the substrate, and $c$ is the velocity of light in free space. The distance between the directors should be $0.1\lambda_g$ to $0.2\lambda_g$.

Theoretically, all the geometrical parameters have effect on the performance of the proposed antenna, but some of them may have more significant effect than others. In the following, two parameters $fl$ and $l_{dri}$ of the proposed antenna, as shown in Fig.1, are analysed and discussed respectively. The antenna exhibits different performances for different combinations of the parameters. Fig.2 gives the return loss of proposed antenna for different values of $fl$ = 5, 6, 7 mm while $l_{dri}$ is fixed at 11.5 mm, from which we can see that the bandwidth is decreasing while $fl$ increases. Fig.3 shows the results for the case of $l_{dri}$ = 10.5, 11.5, 12.5 mm while $fl$ is fixed at 6 mm. It can be seen that the resonant frequency and bandwidth are gradually decreasing while $l_{dri}$ increases.

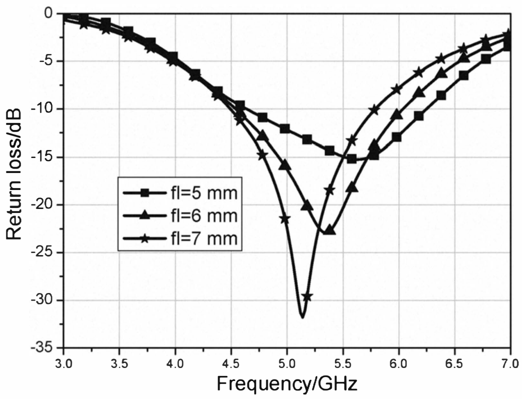


Fig. 2 Effect of parameter $fl$ on return loss

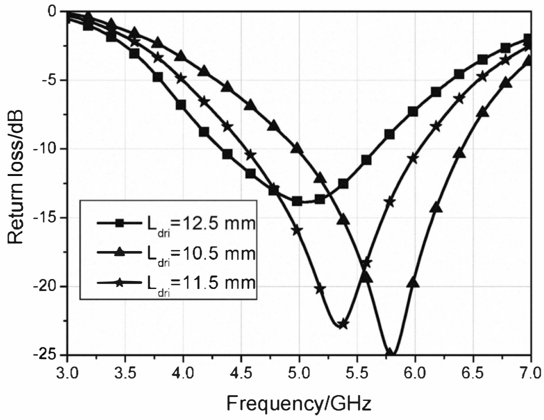


Fig. 3 Effect of parameter $l_{dri}$ on return loss

The antenna was optimized in terms of radiation pattern and gain, and the optimum parameters are given in Table 1.

TABLE 1
OPTIMUM STRUCTURE SIZE OF THE ANTENNA (UNIT: MM)

| parameters | $fl$ | $l_{dri}$ | $s1$ | $l_{dri1}$ | $l_{dri2}$ | $h1$ |
|---|---|---|---|---|---|---|
| size | 6 | 11.5 | 4 | 8 | 6 | 10 |

In the design, the total area of the substrate is $W \times L \times H$ = 28 mm × 35 mm × 1.6 mm.

## III. SIMULATION AND MEASUREMENT RESULTS

### A Impedance Bandwidth

The antenna was fabricated and tested. The simulated and measured return losses are shown in Fig.4. Essential agreement between the measured and simulated results can be seen from this figure. The measured frequency range defined by return loss less than -10 dB is from 4.64 GHz to 6.25 GHz, which covers the two WLAN bands of 5.15 GHz - 5.25 GHz and 5.75 GHz - 5.85 GHz.

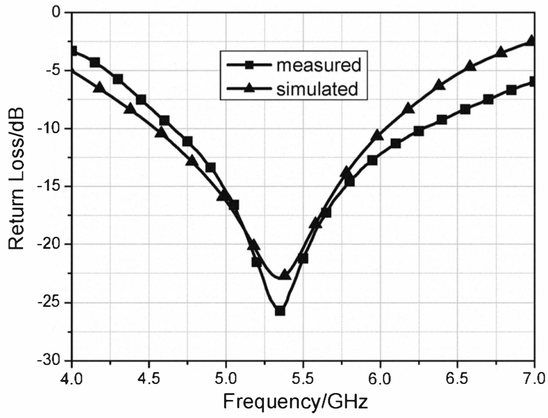


Fig. 4 Measured and simulated return losses of the proposed antenna with optimum structure parameters

### B Radiation Patterns

The simulated and measured radiation patterns for *xoz*-plane and *yoz*-plane of the proposed antenna at 5.2 GHz and 5.8 GHz are shown in Fig.5 to Fig.8 respectively. The figures demonstrate that the antenna can work in end-fire state, and the cross-polarisation level is about -15 dB.

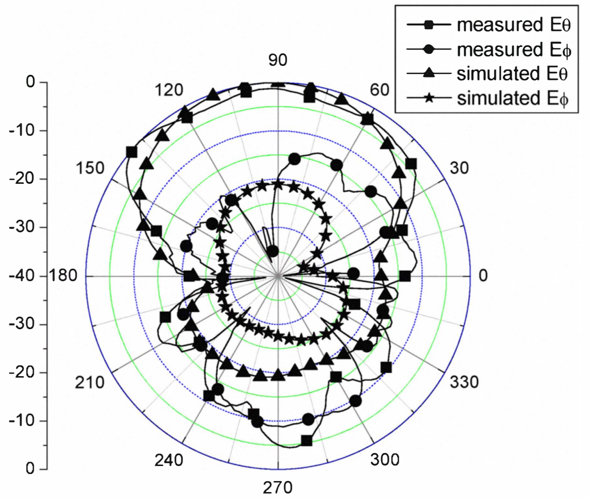


Fig. 5 Radiation patterns of the antenna at 5.2 GHz in *xoz* plane

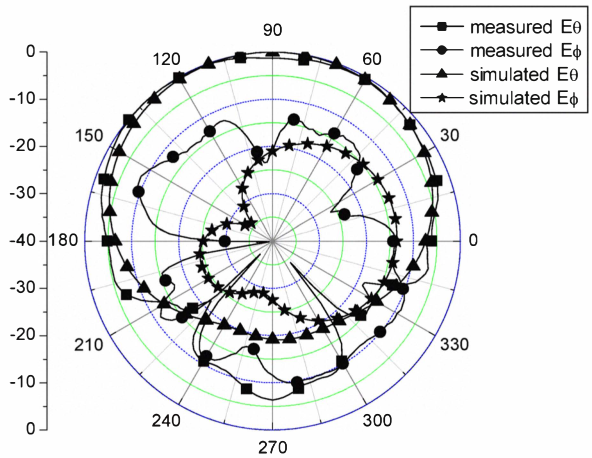


Fig. 6 Radiation patterns of the antenna at 5.2 GHz in *yoz* plane

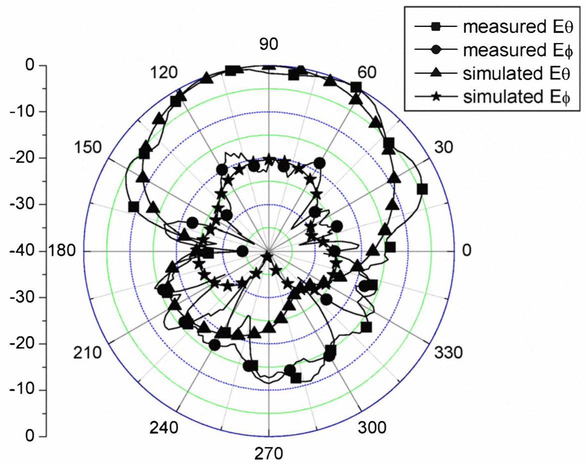


Fig. 7 Radiation patterns of the antenna at 5.8 GHz in *xoz* plane

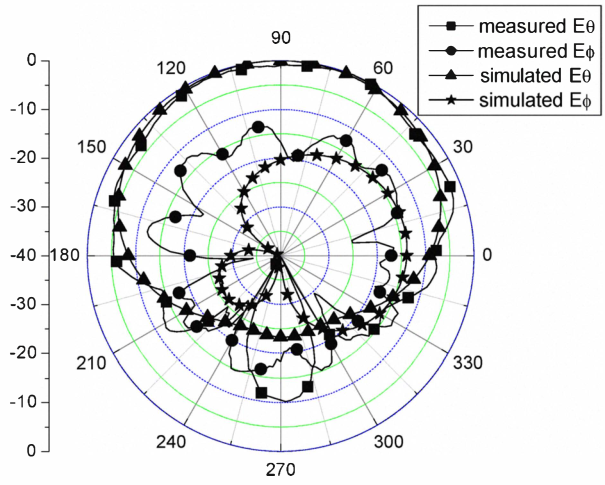


Fig. 8 Radiation patterns of the antenna at 5.8 GHz in *yoz* plane

Fig. 9 gives the simulated antenna gain as function of frequency. From the figure we can see that the antenna gain changes from 5.2 to 7.2 dB within the band.

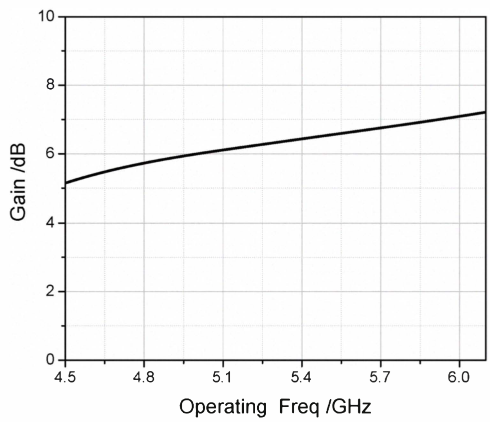


Fig. 9 The gain of the proposed antenna

## IV. CONCLUSIONS

In this paper, a Quasi-Yagi microstrip antenna with simplified feeding structure is proposed and designed, in which the microstrip line and stripline without any complicated balun structure are used. In the design process, a lot works on simulations of antennas with different structural parameters were done by FDTD method, and finally, a set of optimum parameters of the proposed antenna are obtained. It can be seen that the antenna exhibits a good radiation characteristic within the entire frequency band. The simulation and measurement return losses and radiation characteristics of the proposed antenna are in well agreement. In addition, the antenna has the advantages of simple structure, low cost, and easy to integrate with microwave circuits and other solid state devices.

## ACKNOWLEDGMENT

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## REFERENCES


[1] J.R. Brianeze, "Tridimensional Yagi Antenna," *Microwave and Optoelectronics Conference (IMOC)*, Nov., 2009, pp. 432-436.

[2] Warren L. Stutzman and Gary A. Thiele, *Antenna Theory and Design*, 2nd ed., New York, Wiley, 1998.

[3] Kretly,L.C, Ribeiro,A.S., "A novel tilted dipole quasi-Yagi antenna designed for 3G and bluetooth applications," *Microwave and Optoelectronics Conference (IMOC)*, Sep., 2003, pp. 303-306.

[4] J. Sor, Y. Qian, and T. Itoh, "Coplanar waveguide fed quasi-Yagi antenna," *Electron. Lett.*, vol. 36, pp. 1–2, Jan., 2000.

[5] W. R. Deal, N. Kaneda, J. Sor, et al, "A new quasi-Yagi antenna for planar active antenna arrays," *IEEE Trans. Microw. Theory Tech.*, vol. 48, pp. 910-917, Jun., 2000.

[6] N. Kaneda, W. R. Deal, Y. Qian, et al, "A broadband planar quasi-Yagi antenna," *IEEE Trans. Antennas Propag.*, vol. 50, pp. 1158–1160, Aug., 2002.

[7] Grant S. Shiroma and Wayne A. Shiroma, "A two-element L-band quasi-Yagi antenna array with omnidirectional coverage," *IEEE Trans. Antennas Propag.*, vol. 55, pp. 3713-3715, Dec., 2007.

[8] G. Zheng, A. A. Kishk, A. W. Glisson, et al, "Simplified feed for modified printed Yagi antenna," *Electron. Lett.*, vol. 40, pp. 464–466, Apr., 2004.