High Gain Yagi-Uda Origami Antenna

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Abstract **- In this paper, a high gain yagi-uda Origami antenna is introduced. Antenna is realized on a paper substrate by using origami tetrahedron structure. The radiating aperture comprises a triangular shaped monopole and two strip directors. The proposed antenna is verified by simulation and measurement results. The fabricated antenna demonstrates a peak gain of 9.6dBi at 2.6 GHz with impedance bandwidth of 66% (2-4 GHz).**

Index Terms **— Yagi-uda antenna, origami antenna, high gain antenna.**

1. Introduction

Yagi-Uda antennas play an important role in various modern wireless communication technologies, because of their properties like low cross polarization level, moderate gain and high radiation efficiency. In literature, various Yagi-Uda antennas have been presented. For instance, in [1] Yagi-Uda antenna is designed by using double dipole drivers and large size reflector. A co-planar waveguide (CPW)-fed Yagi antenna is designed by elliptical shape of a driven element and directors [2]. In [3] a high gain Yagi wire patch antenna is presented. A high gain vertically multilayered stacked Yagi antenna is designed [4].

In addition, Origami is a Japanese word used for paper folding. It has been used in various fields like architecture, energy harvesting and space born applications. The folding capabilities of origami can have significant advantages in electromagnetic applications because of easy and low cost manufacturing process.

In literature, few antennas are designed by using origami structures. In [5], a 3-dimensional (3-D) accordion shaped origami antenna is designed for frequency reconfigurable applications. In [6], a mode reconfigurable helical origami antenna is presented. An origami antenna is designed by using an origami spring structure [7].

In this paper, a high gain Yagi-Uda origami antenna is presented. The antenna is built on the paper substrate by using an origami tetrahedron structure. The designed antenna consists of a triangular shaped monopole and two parasitic strip directors. Two directors play an important role to increase antenna's peak gain. Because the proposed antenna is built on the paper substrate, it provides low cost, fast and easy fabrication procedure. The designed antenna presents a peak gain of 9.5 dBi at 2.6 GHz with impedance bandwidth of 66% (2-4 GHz).

2. Antenna Design and Performances

The proposed antenna is designed on a paper substrate in an origami tetrahedron shape. The designed antenna consists of a triangular shaped monopole (the driven element), a reflector, and two directors.

The origami antenna design and folding process can be divided in several steps. Firstly, four different square paper sheets with the same area (270 mm × 270 mm) and a thickness of 0.25 mm are employed. These paper sheets are labeled I, II, III and IV. Secondly, sheet I is selected as the substrate for the driven triangular patch as well as for the two antenna directors realized. A 135 mm × 135 mm copper film is attached on a quarter section of sheet I to serve as the reflector for the antenna. This paper is folded to make a star like shape which consists of four pockets.

In a second step, sheets II, III and IV are utilized. Two copper films with different dimensions (270 mm × 135 mm and 135 mm × 135 mm) are attached to one half section of sheet II and a quarter section of sheet III, respectively, to serve as the reflector in the final antenna design. Sheets II, III and IV, are folded to make three additional stars. At the end of step 2, we will therefore have four different stars, which can be labeled as stars 1, 2, 3, and 4 for paper sheets I, II, III and IV, respectively.

In a third step, stars 1, 2, 3, and 4 are joined to complete the prototype of the antenna as displayed in Fig.1.

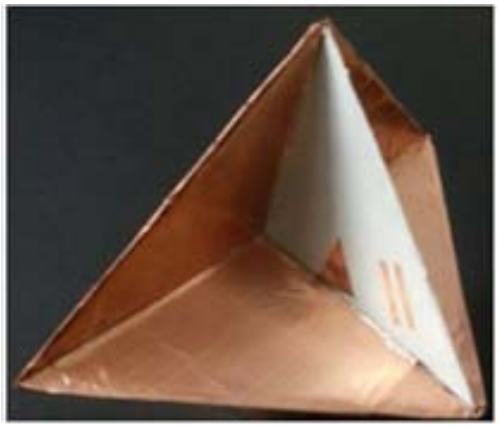

Fig. 1. Picture of the fabricated Yagi-Uda origami antenna

In order to expect its performances, ANSYS high frequency structure simulator (HFSS) is used for the design and simulation of the proposed antenna. The dielectric constant and dielectric loss tangent of the paper are considered as 2.1 and .02 respectively.

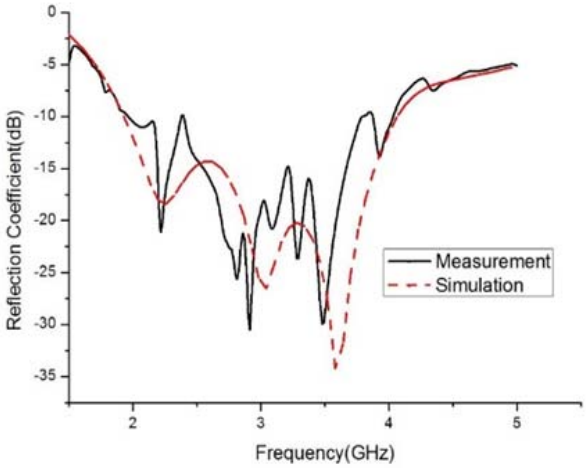

Fig. 2. Simulated and measured reflection co-efficient

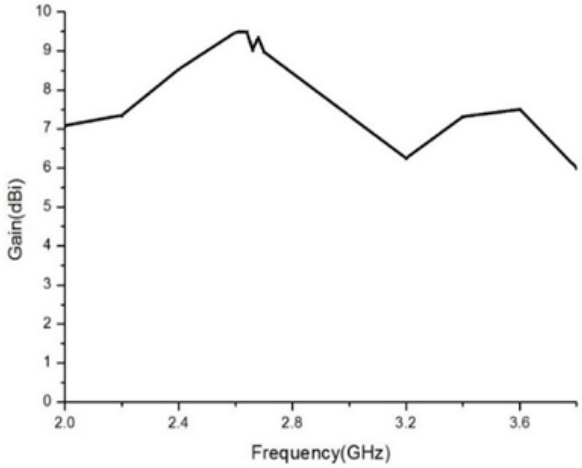

Fig. 3 Measured antenna's peak gain as a function of frequency.

In order to measure its performances, a SMA connector is mounted at the port of the antenna. In Fig.2, the simulated and measured reflection coefficients of the proposed antenna are presented. 10 dB impedance bandwidth is achieved from 2 GHz to 4 GHz which corresponds to 66%. There is a slight difference between simulated and measured results due to fabrication errors.
The measured antenna's peak gain is plotted in Fig. 3 for different frequencies. At 2.6 GHz, the antenna's peak gain is 9.5 dBi.

3. Conclusion

A high gain Yagi-Uda type origami tetrahedron antenna is presented on paper substrate. The fabricated antenna shows a peak gain of 9.6 dBi at 2.6 GHz with impedance bandwidth of 66%. Due to paper folding origami, the proposed antenna shows low cost, easy and fast manufacturing process.

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