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A Modified YAGI-UDA Antenna with Stepped Width Reflector

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Abstract – *Antenna is a metallic device which is used for transmitting and receiving an electromagnetic signal. An antenna array is designed by combining number of similar antenna by doing so, one can achieve array, increasing directivity and radiation in particular direction.*

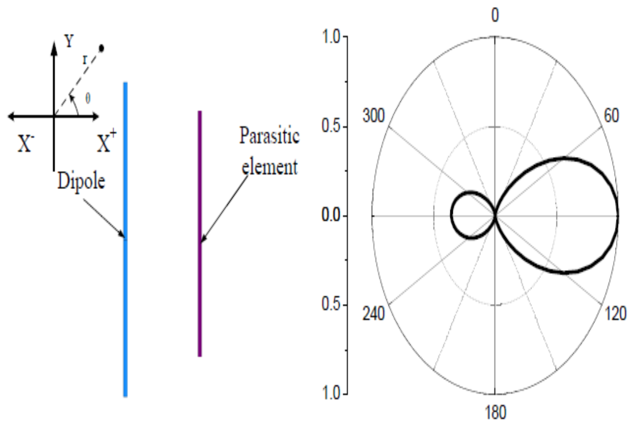
A YGI-UDA antenna with stepped width reflector is studied in the seminar. Totally different with the traditional ones, the proposed reflector is shorter than the driven element as a result of the stepped with structure. To further understand it's working mechanics, an equivalent circuit to a dipole with a parasitic element is employed to explain the shortened length of the stepped width reflector, shorter than the driven element was applied to the design, fabrication and measurement of YGI-UDA antenna. The benefit of such structure is shorter size & increases the value of gain.

Key Words: Stepped width structure, a dipole with parasitic element, and equivalent circuit, YGI-UDA antenna, miniaturized reflector.

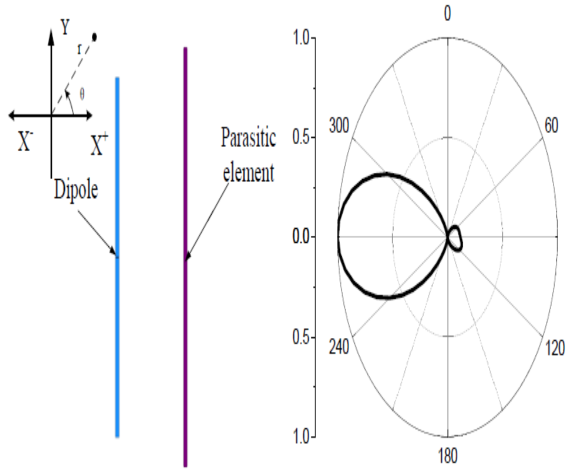
1. INTRODUCTION

Parasitic element antenna, which is now widely used in communication systems, has great potential in terms of frequency and radiation pattern agility. Compared to a single element antenna, PEA offers a greater degree of freedom, and does not suffer from the bulky feed distribution network of antenna arrays. YGI-UDA antenna is a typical type of PEA and is widely used in modern communication systems. In precedent literatures, uniform-width structures were employed in reflectors, directors and driven elements. The driven elements were always longer than the directors and shorter than the reflectors. When the reflectors were longer than driving elements, they would inevitably increase the overall size of the antenna. For minimization, cylindrical covers were employed to reduce the size of antennas, but the structure was complex. A stepped-width dipole was employed in to reduce the size of the driven element, but the reflector and the overall size of the antenna was still large.

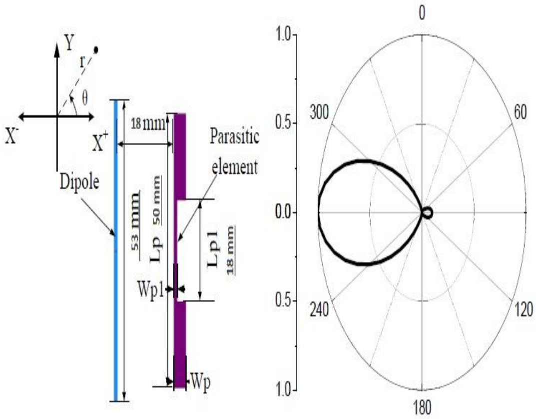
In the filter with stepped-width was used in filter minimization. This method can also be constructively used in designing miniaturized reflector. In this paper, a stepped-width reflector is presented and analyzed by an equivalent circuit. In the equivalent circuit, the parasitic element is equivalent to a resistor loaded in a short circuit line. The stepped-width structure applied in reflector shortening the reflector in comparison to the driven element can decrease the resonate frequency, as also the size of the reflector. A YGI-UDA antenna, involving the proposed miniaturized reflector, was designed, fabricated, and measured to confirm the proposed concept.



A) A dipole with uniform-width director



B) A dipole with uniform-width reflector



C) A dipole with stepped width reflector

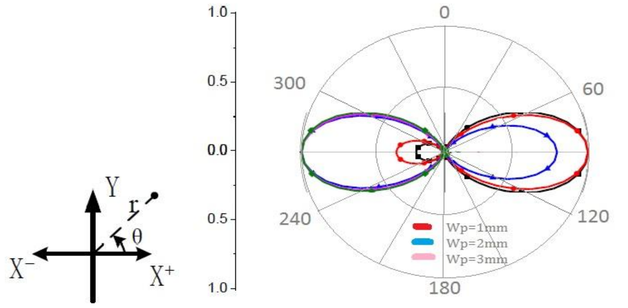


Fig.3. Radiation patterns under varied width Wp for the proposed dipole with a parasitic element in Fig.1 (c).

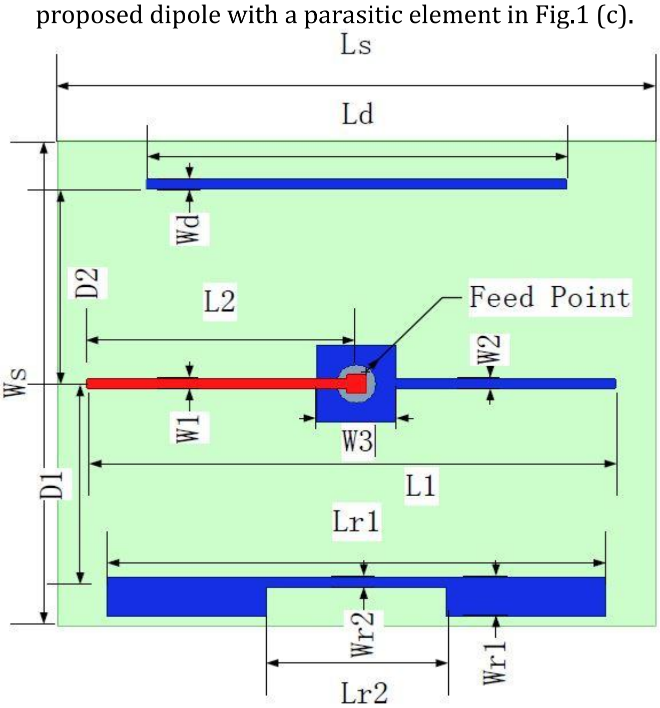


Fig.4. Dimension of proposal antenna

2. MINIATURIZED REFLECTOR WITH STEPPED-WIDTH STRUCTURE

As usual, a half-wavelength dipole is selected as the driven element. A dipole with a stepped-width parasitic element and its E-plane radiation pattern are shown in Fig.1 (d). The dimensions are chosen as follows: Wp1=1 mm, Lp1=18 mm, Lp=55 mm, Wp=3 mm,. Obviously, the length of the stepped-width parasitic element is shorter than the dipole. However, based on the radiation pattern, the stepped-width parasitic element acts as a reflector, which is different from the uniform-width ones. The above dimension are shown in fig(C)

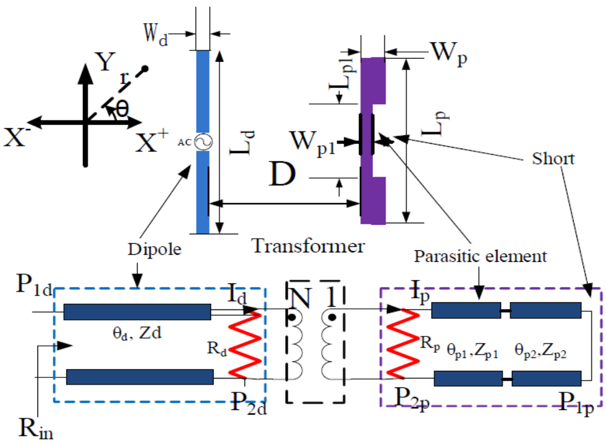


Fig.2. A dipole with a step-width parasitic element and its equivalent circuit

When we change the value of W_{p1} i.e. increase the value W_{p1} along with changes in the radiation curve. Figure 3. Show the radiation pattern changes

Table -1: Dimension of Proposal antenna in (mm)

Measurement in (mm)			
Parameters	Value	Parameters	Value
Ls	60	W3	8
Ws	50	L1	53
Lr1	50	L2	22
Lr2	18	Ld	42
Wr1	4	Wd	1
Wr2	1	D1	18
W1	1	D2	20
W2	1		

Now, a simple simulation is implemented to certificate that the stepped-width parasitic element can be used to reduce the size of reflector. Fig.3 depicts radiation patterns under varied width Wp for the proposed dipole with the parasitic element in Fig.1 (c). When Wp=1mm, the parasitic element is with a uniform-width structure. Because the parasitic element is short than the dipole, the main beam radiates toward in the X+ direction and the parasitic element plays a role as a director. The parasitic element changes from a director to a reflector as the width of Wp increases. When Wp=3 mm, the main beam radiates toward in the X- direction and the parasitic element is a reflector bring to 20 dB front-to-back ratio

3. Results

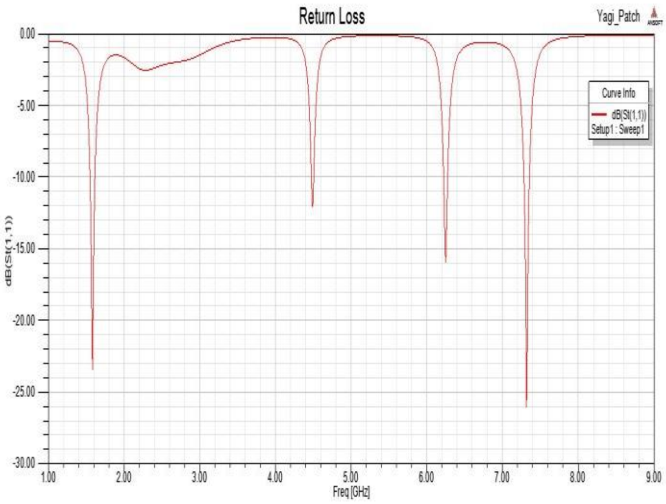


Fig.5.Simulated and measured results of |S11|

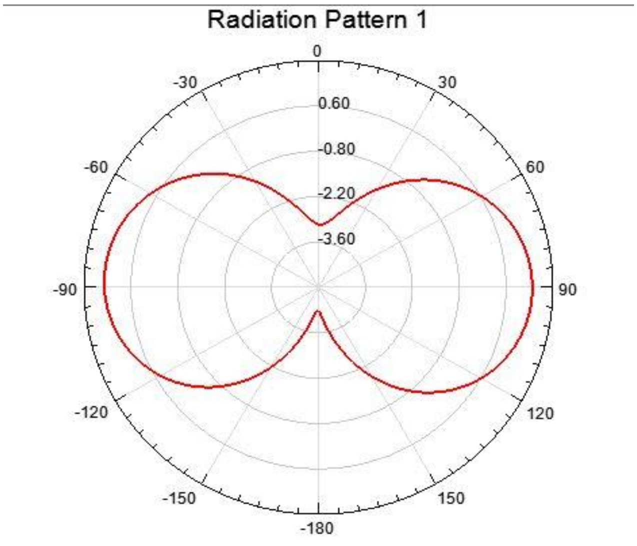


Fig.6. 2-D Radiation pattern in dB

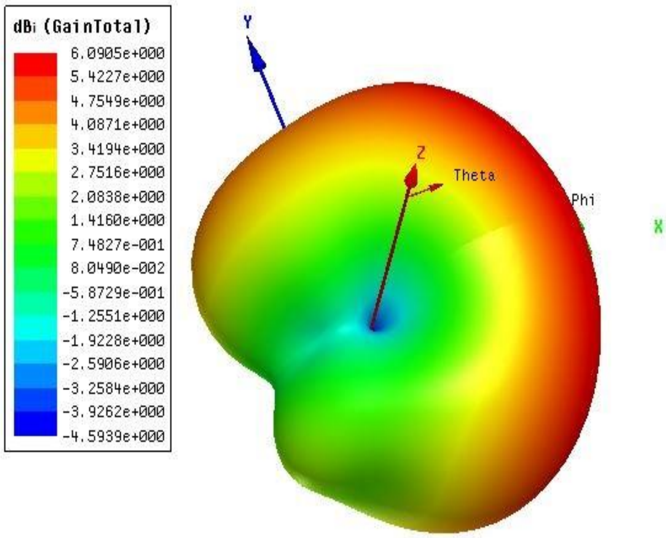


Fig.7. Antenna Gain in (dBm)

4. Application in a YAGI-UDA antenna

Based on above discussion, a modified YAGI-Uda antenna with a stepped-width reflector was designed. The dimensions of the antenna are shown in Fig.4. The overall size of the antenna was (60*50*0.8) mm^3. The antenna is printed on the FR4 substrate ($\varepsilon_r = 4.4$) and fed by a coaxial line. An antenna was employed to reduce the overall size of the antenna. The total length of the driven was 53 mm and that of the reflector element 50 mm. The stepped-width reflector was shorter than the driven element.

The simulated results are in good ones. Reflection coefficient of the proposed antenna is shown in Fig.5. In the frequency band from 1.5 to 7.5 GHz, |S11|<-10 dB. Radiation patterns of the antenna are shown in Fig.6. It can be seen that the gain is about 6 dBi. The gain of the proposed antenna is about 6 dBi as shown in Fig.7.

5. CONCLUSIONS

In this seminar a modified YAGI-Uda antenna which is operating in range of 1.5-7.5 GHz is studied. We conclude from this study that, due to modification in width of reflector (stepped width) the size of antenna get reduced and gain can be increase.

We had to be design above antenna using HFSS. HFSS is finite element mentioned (FEM) based software to an example we can simulate an MODIFIED YAGI-UDA ANTENNA with STEPPED WIDTH REFLECTOR shaped micro strip patch antenna and obtain result in terms of parameter like reflection coefficient, gain and VSWR current generated by antenna.

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