



Directional Yagi Uda Antenna for VHF Applications

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Abstract

This paper describes the design of a 6 element Yagi Uda antenna for VHF band applications. It consists of a dipole, reflector and four directors. The design frequency (165 MHz) is chosen at the middle of the VHF band (30 to 300 MHz). Increasing the height of the reflector significant improvement in gain and directivity is achieved. The antenna is designed and simulated in CST microwave studio.

Keywords: Yagi-Uda; Dipole; Reflector; Director; VHF; Gain; Directivity; CST

Introduction

Yagi Uda antenna was introduced by Shintaro Uda and Hidetsugu Yagi in 1920 [1]. It is a highly directional antenna and widely used in to receive TV signals. Now a day's Yagi -Uda antennas are also used in the fields of RADARs, satellites and RFID applications [2]. It consists of a dipole, reflector and directors. Usually dipole is fed at the center that induces currents in parasitic elements of the array through mutual coupling. The gain depends on the geometry of the antenna. Director is highly resonant and is operated at a lower frequency than dipole. Directors provide directional capability to the antenna. As number of directors increase gain increase but decreases HPBW and affects front to back ratio with increasing back lobe [3,4]. If element is tilt by some angle theta, gain decreases and HPBW increases [5]. Usually reflector is placed behind the dipole, it is a bit longer than dipole but its operating frequency is lower than dipole. The length and spacing of reflector shows significant impact on gain, directivity and radiation pattern of the antenna.

Antenna Design

The antenna is designed to operate at the center frequency (165 MHz) in VHF band (30 -300 MHz). This antenna consists of 6 elements in which there are 4 director elements. As the number of directors increase antenna become bulky and HPBW decreases. Hence, instead of increasing the number of directors, reflector height is increased to obtain high gain and directivity. Reflector height is optimized as mentioned in Table 1. Te 6 elements Yagi Uda antenna is shown in the Figure 1. The design values are computed as

- Lambda =1.81m
- Reflector = 0.479λ
- Dipole = 0.451λ
- Director = 0.422λ
- Spacing = 0.25
- Wire radius 0.00425λ
- Spacing between reflector and dipole is 0.4300
- Reflector height 0.8750

Simulation Results

The proposed antenna is designed and simulated in CST microwave studio. The proposed antenna performance is compared with the

performance of antenna in the study done by Shinde et al. [1]. In the reference antenna a curved surface reflector is used to improve the gain. In this paper we have not changed the shape of the reflector, but optimized the height of the reflector to improve the 6 element Yagi - Uda antenna performance. The proposed antenna is resonating at 168 .78 MHz covering the VHF band. Figure 2 show that the proposed antenna is showing a very good return loss (-19.40). Figure 3 shows that the proposed antenna is showing better VSWR (1.23) than reference antenna (1.3). Form Figure 4 it is observed that the proposed antenna gain and directivity is 11.19 and 11.32. Reference antenna gain is 9.67 DBi. The proposed antenna gain is 1.52 DBi more than reference antenna. The proposed antenna is more directional than reference antenna [6-8]. Further the antenna is showing a very good radiation efficiency (Figure 5) and front to back ratio (Figure 6).

Units	Calculated values	Optimized values
Reflector	0.8669m	0.8750m
Dipole	0.8163m	0.8163m
Director 1,2,3,4	0.7638m	0.7638m
Wire radius	0.0076m	0.0076m
Spacing between elements	0.4525m	0.4525m

Table 1: Design Parameters of 4 element Yagi Uda antenna.

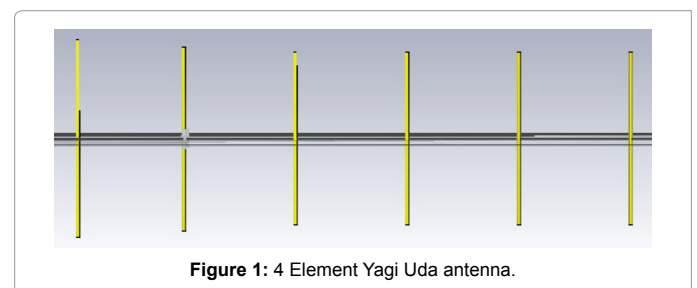


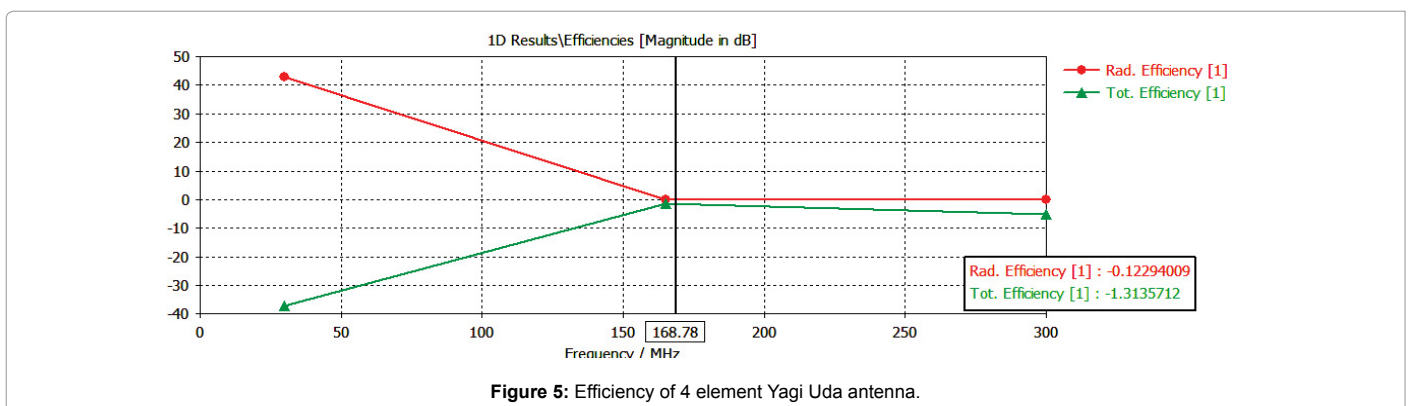
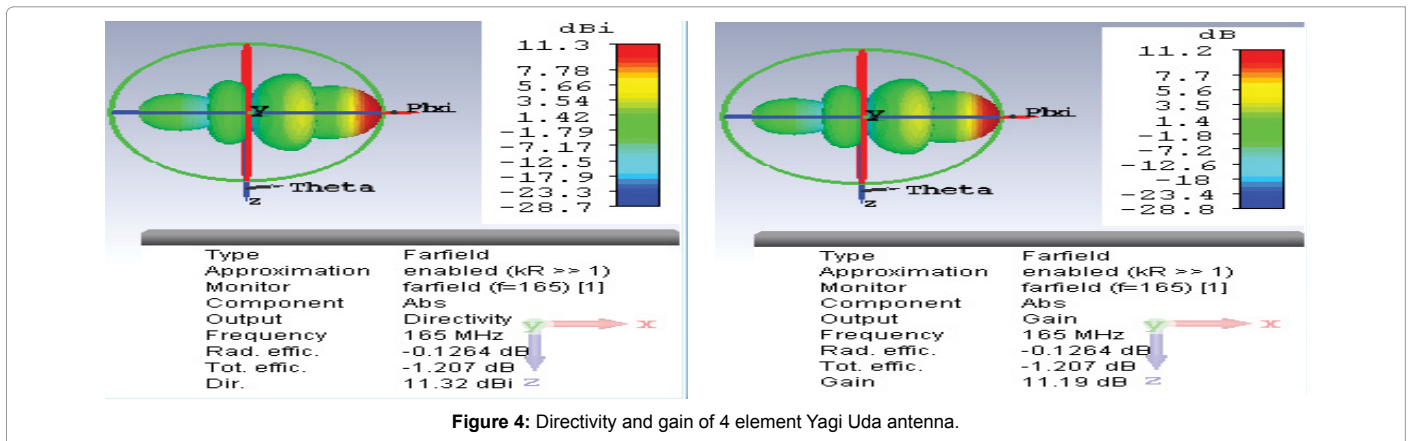
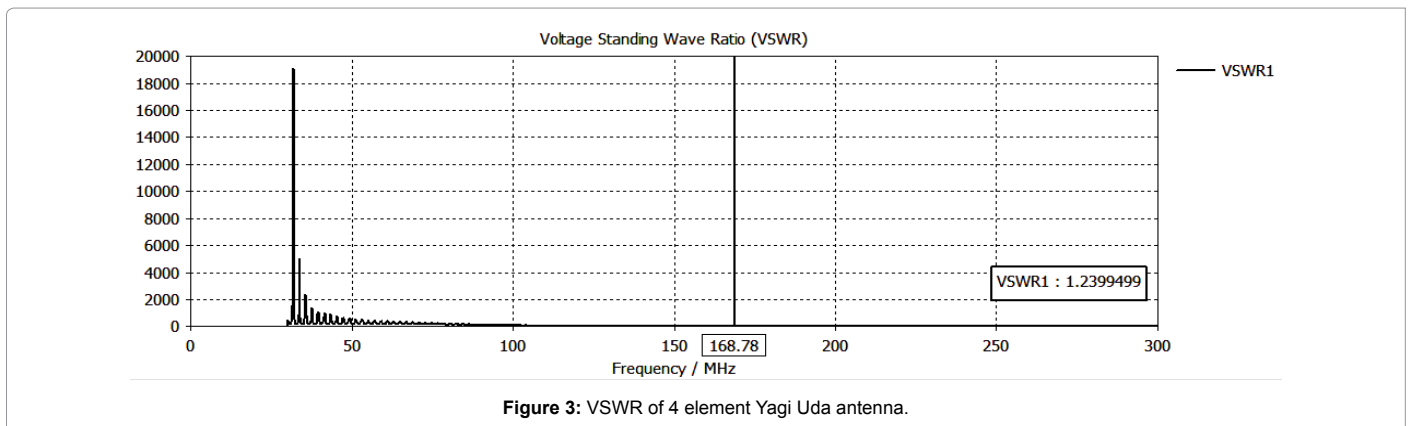
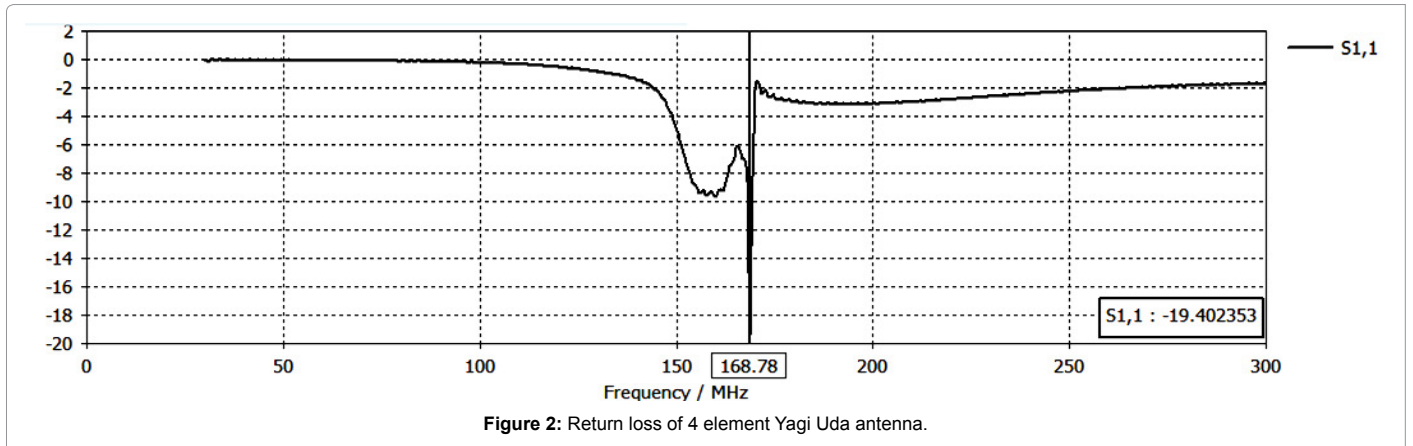
Figure 1: 4 Element Yagi Uda antenna.

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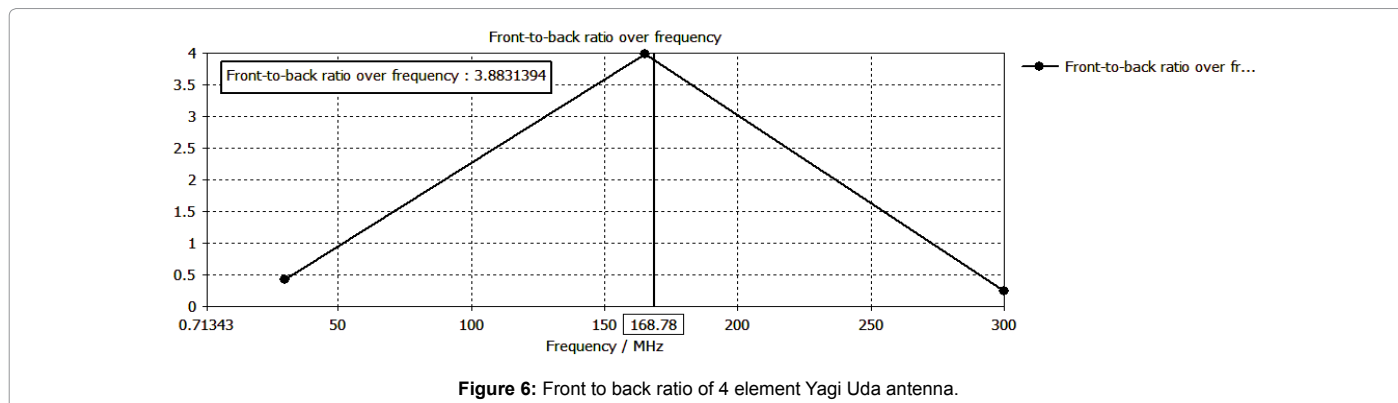


Figure 6: Front to back ratio of 4 element Yagi Uda antenna.

Conclusion

This paper describes reflector size optimization technique to improve the gain without using an additional director. The proposed antenna obtained a forward directivity 11.32 dBi and gain 11.16 dB. This is a better gain and directivity as compared with reference antenna. A return loss of - 19.40 dB and VSWR is 1.23 is achieved for designed antenna at 165 MHz. So the proposed antenna is a good choice for VHF band applications.

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