Comparison between hollow aluminum yagi-uda and dipole antenna for indoor antenna TV

by Suci Rahmatia

Comparison between Hollow Aluminum Yagi-Uda and Dipole Antenna for Indoor Antenna TV

Dessy Indah Savitri, Azmi Azizah Azzahra, Putri Wulandari, Suci Rahmatia

Al Azhar Indonesia University, Jl. Sisingamangaraja, Kebayoran Baru, RT.2 / RW.1, Selong, Kby. New, South Jakarta City, Jakarta Capital Special Region 12110, Indonesia

E-mail: dessyindahsavitri@gmail.com

Abstract. This paper is talking about comparison between Hollow Aluminum Yagi-Uda Antenna and Dipole Antenna quality based on position of the antenna using CST Microwave studio simulation which the element of Dipole antenna has a same size with the driven element of Yagi-Uda Antenna. In this research, each antenna is placed in four different places which representate high place, low place, indoor, and outdoor. While the simulation result of antenna using CST Microwave studio will be analyzed based on some characteristics of antenna that is Return Loss, VSWR, Gain, and Directivity. In the end, both results will be compared and analyzed to get a recommendation for the best type of antenna which can fit with the provision of the frequency, condition, and parameter that specified before.

Keywords: Hollow Aluminium, Yagi-Uda Antenna, Dipole Antenna

1. Introduction

The Antenna is a tool that used to catch a signal of electromanetic waves which are then used to watch television, listen to music, use a modem or wifi [1]. The Antenna has a variety of types, two of them namely Yagi-Uda Antenna that has directional radiation pattern which consists of three main components (a pair of driven, reflector, and director) and Dipole Antenna that has omnidirectional radiation pattern which has only two components that face each other [2]. Both of these antennas have different qualities that will be discussed further in this research.

2. Theory

Yagi-Uda Antennais an antenna which has directional radiation pattern so it has a larger gain but more narrow transmission area [2]. This antenna has three main elements, driven elements, reflector and director. When this antenna use more directors, the gain will be getting bigger but the radiation area will be more narrow. To obtain maximum results, it takes the right combination on the driven, reflector, director, gap, and the distance between each element that can be simulated with CST Software. As for the usual early equation used is as follows:

$$\lambda = \frac{c}{f} \tag{1}$$

$$length\ of\ driven = 0.47x\lambda \tag{2}$$

$$length\ of\ reflektor = \frac{153}{f} \tag{3}$$

$$length\ of\ director = \frac{137}{f} \tag{4}$$

Dipole Antenna is an antenna which has omnidirectional radiation pattern, so this antenna has a smaller gain but the area was more widely [2]. This type of Antenna has two main elements that face each other.

There are several things that can be used as a parameter to see the performance of the antenna, that is Return Loss (usually depicted with S-Parameter graph), VSWR, and farfield directivity and gain. Return Loss is a parameter to measure how much power is lost because it can not reflected back. The value of maximal return loss that can be accepted is -10dB [3]. VSWR is a parameter that shows the

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comparison value about the power that reflected and transmitted from the antenna. The value of maximal VSWR on antenna which shows that antenna matched with receiver or in the other word, the value that can be accepted is < 2 [3]. Directivity and gain in antenna farfield show a comparison between maximum radiation intensity and isotropic radiation intensity and also comparison how much energy that received and transmitted to an antenna [5].

3. Research Method

In this research, two antennas that is Hollow Aluminum (rectangular) Yagi-Uda and Dipole using television's frequency in Indonesia (470-890MHz) will be compared to see the quality of both antenna with some parameters like the number of noises, interference, and light intensity.

4. Result and Discussion

4.1. Parameter List

In Table 1 shows parameter list that must be determined to help user if want to change the value of the elements

Table1. Parameter List

Name	value (cm)
Distance	4
Length driv	27
Length_direc1	17
Length_direc2	20
Length_direc3	22
Length_ref	36
D_dir1todir2	9,6
D_dir2todir3	9,6
D_drivtodir1	6,6
Side	1,27
D_reftodriv	8,8
Thick	0,1

Besides that, the limit value of the VSWR<2, ReturnLoss<-10.

4.2. S-Parameter (Return Loss) result from CST simulation

4.2.1. Dipole Antenna

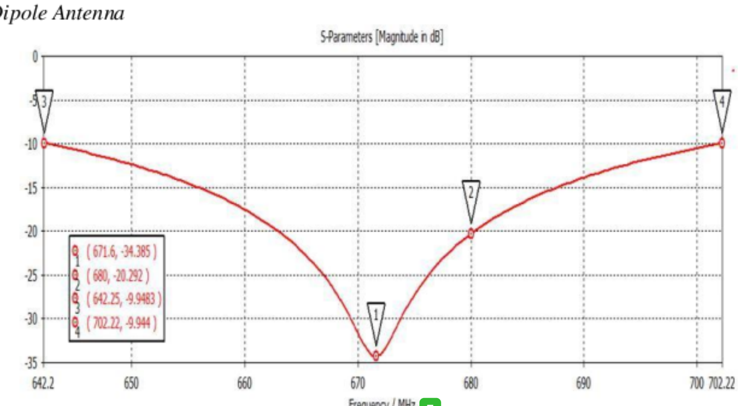

Figure1. S-Parameter of Dipole Antenna

Figure 1, shows the bandwidth range of dipole antenna is 641.79-702.22 MHz. According to the simulations, the frequency of television broadcasts that can be received by an antenna is in that number. The value of center frequency is in -20.292and the lowest point from this S-Parameter is -34.385 which is in frequency 671.6 MHz.

4.2.2. Yagi-Uda Antenna

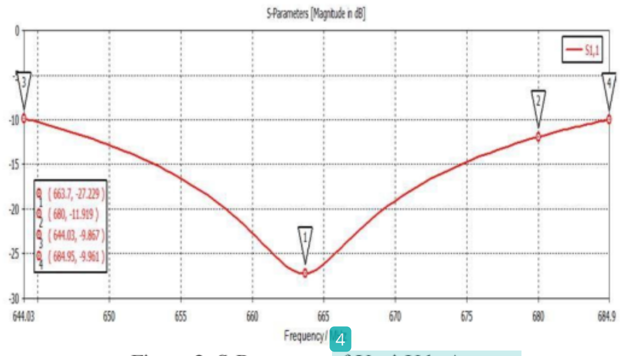

Figure 2. S-Parameter of Yagi-Uda Antenna

Figure 2 shows the bandwidth range of dipole antenna is 644.03-684.95 MHz. The value of center frequency is in -11.919 and the lowest point from this S-Parameter is -27.229 which is in frequency 663.7 MHz.

From the result of both graph antenna, can be seen that yagi-uda antenna which has the same size of driven element with dipole antenna has smaller bandwidth range than dipole antenna. This is because yagi-uda antenna has directional radiation pattern which has narrower radiation area so the bandwidth range will be narrower [6].

For the return loss value, yagi-uda should have a graph of s-parameters more sharply downwards or return loss values are smaller but based on the results of the simulation, for the same size of yagi-uda driven, yagi-uda's return lossis larger than dipole. This might be due to a combination of factors are components of yagi-uda selected less fitting size. In fact, it is still possible to get a good chart but the size of the reflector and Director yagi-uda produced will be bad if applied on indoor television antenna [7].

4.3. VSWR result

4.3.1. Dipole Antenna

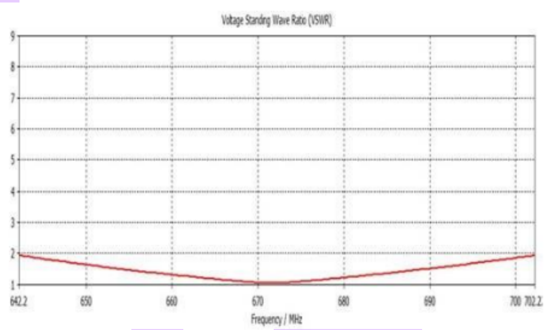

Figure 3. VSWR of Dipole Antenna

Figure 3 shows the VSWR from dipole antenna. Based on that figure, the VSWR value in center frequency (680MHz) is 1.2141 and VSWR value in the lowest point is 1.0389which is in frequency 671.59 MHz.

4.3.2. Yagi-Uda Antenna

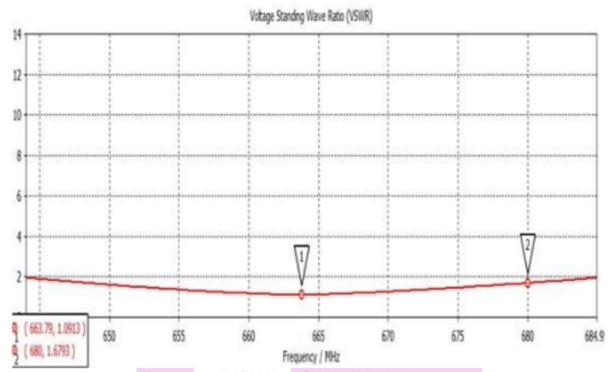

Figure 4. VSWR of Yagi-Uda Antenna

Figure 4 shows VSWR for Yagi-Uda antenna. Based on that Figure, the VSWR value in center frequency (680MHz) is 1.6793and VSWR value in the lowest point is 1.0913 in frequency 663.79 MHz.

From both graphs, yagi-uda antenna has a value of VSWR which not better than Dipole Antenna. that is not accordance with the theory of antenna which is yagi-uda should has VSWR value better than dipole's VSWR because yagi-uda has reflector that can reduce a wave interference [8].

4.4. Farfield result from CST simulation
4.4.1. Dipole Antenna

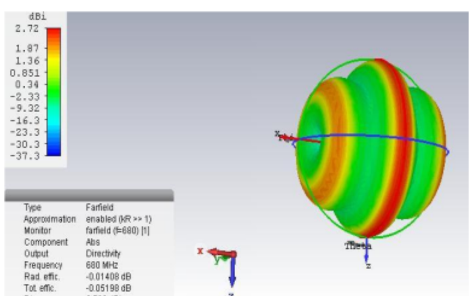

Figure 5. 3D Farfield Directivity Dipole Antenna 680 MHz

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4.4.2. Yagi-Uda Antenna

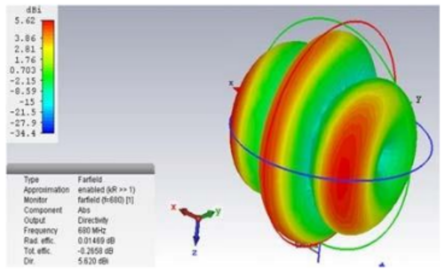

Figure 6. 3D Farfield Directivity Yagi-Uda Antenna 680 MHz

Figure 5 and figure 6 shows 3D images for farfield directivity, polar and gain on the antenna dipole and yagi-uda antenna. That figures can see that dipole has value directivity and gain is smaller than yagi-uda. This is due to dipole antenna are omnidirectional radiation pattern where the radiation was expanded in all directions so that the resulting directivity and gain a little more because it does not focus on one direction such as a yagi-uda.

4.5. Experiment result using Rectangle Hollow Aluminum Yagi-uda and Dipole Antenna

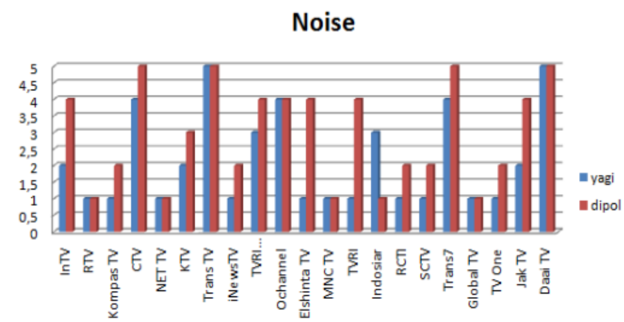

Figure 7. Graph of Noise Comparison Yagi-Uda and Dipole

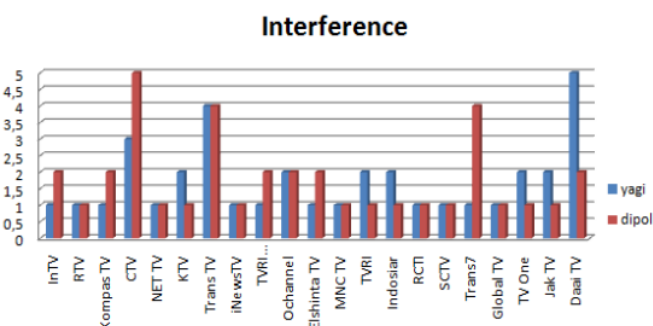

Figure 8. Graph of Interference Comparison Yagi-Uda and Dipole

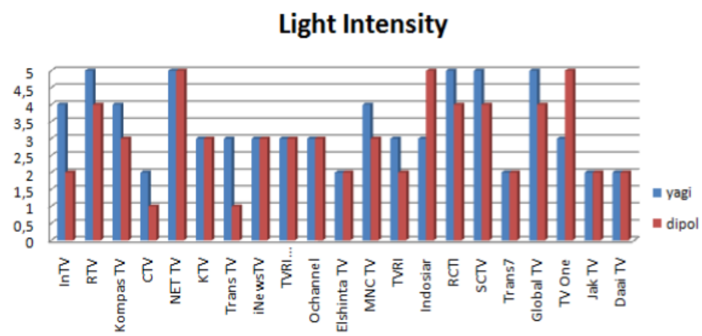

Figure 9. Graph of Light Intensity Comparison Yagi-Uda and Dipole

According to noise, interference, dan light intensity graph comparison, the quality of yagi-uda antenna is better than dipole in case of lower noise and interference and higher light intensity. This is because yagi-uda antenna has reflector and director to increase the gain and power so the broadcast quality is better.

5. Conclusion

Based on experiments conducted using CST Software measurement of quality with the antenna mounted on the television, yagi-uda antenna have better quality compared to a dipole antenna because although the value of S-parameter and VSWR is higher than dipole, the image quality in television is very good and clear which is better than dipole. In addition, to get a better broadcastquality, placed antenna in the highest position. Later, the frequency of the channel bandwidth inthe range will be excellent quality and getting away from the range of bandwidth quality will increasingly decline.

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