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Performance and Design Analysis of Dipole, Yagi and Parabolic Reflector Antenna

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Abstract – Abstract - Antennas are frequency-dependent devices. The design of each antenna depends on the frequency band it will operate in. An antenna rejects every signal that is outside its operating band. Thus the antenna may be also seen as a bandpass filter. Antennas are essential parts in communication systems. Therefore, understanding their principles is important and this will be covered in subsequent sections of this work.

Keywords – Antenna, radiation pattern, Frequency

I. INTRODUCTION

Antenna is a transducer designed to transmit or receive radio waves by converting radiofrequency electrical currents into electromagnetic waves and vice versa. They exist in various shapes and sizes, namely; log-periodic, rhombic, ferrite, Yagi antenna, etc.

The discovery of electromagnetic waves and antennas totally and permanently changed the way humans communicated from one person or place to the other. The existence of electromagnetic waves was predicted by James Clerk Maxwell in 1865, confirmed by Heinrich Hertz in 1885 and used by Guglielmo Marconi in 1901. At about that same time the Hertz antenna was invented to develop a radiotelegraph system (Ochala and Okeme, 2011).

James Clerk Maxwell formulated the mathematical model of electromagnetism (classical electro-dynamics), "*A Treatise on Electricity and Magnetism*", 1873, in which he showed that light is an electromagnetic (EM) wave, and that all EM waves propagate through space with the same speed, the speed of light.

In 1886 Heinrich Rudolph Hertz demonstrated the first wireless EM wave system using a $\lambda/2$ dipole excited with a spark. The dipole radiated predominantly at 8 m and a spark appeared in the gap of a receiving loop some 20 m away. In 1890, he published his memoirs on electrodynamics, replacing all potentials by field strengths.

The fundamental antenna concepts and a brief introduction to the types of antenna have been discussed. Three antenna prototypes along with their basic specifications have been verified at specific operating frequencies and their design details were presented in the document. The reflector antenna, Yagi antenna and the half wave dipole antenna were designed, simulated and tested. From both the simulation result and the experimental results various characteristics and parameters of these antennas were studied.

In 1892, Tesla delivered a presentation at the IRE of London about "transmitting intelligence without wires," and, in 1895, he transmitted signals detected 80 km away. His patent on wireless links preceded that of Marconi.

The beginning of 20th century (until WW2) marked the boom in wire-antenna technology (dipoles and loops) and in wireless technology as a whole, which is largely due to the invention of the DeForest triode tube, used as a radio-frequency (RF) generator. Radio links were realized up to UHF (about 500 MHz) and over thousands of kilometers. WW2 brought a new era in wireless communications and antenna technology. The inventions of new microwave generators (magnetrons and klystrons) lead to the development of the microwave antennas such as waveguide apertures, horns, reflectors, etc.

An antenna may be resonant or non-resonant. A resonant antenna is that in which current distribution exists as a standing wave pattern. They radiate electromagnetic energy equally in all directions and are said to be omnidirectional. Examples are loop, ferrite rod antenna etc (Roddy and Coolen, 2007)**.** A non- resonant antenna is that in which current exists as a travelling wave. It radiates electromagnetic energy in a unidirectional manner. Examples are Yagi, long-wire, rhombic, log periodic antenna, etc. These antennas are effective for short-link communication unlike the resonant antennas which are effective for long-link communication.

A. Antenna Characteristics

Antennas have the function of converting one type of wave into another. The direction of energy conversion is irrelevant as far as the principle of operation and the understanding thereof are concerned. The transmitting and the receiving antenna can therefore be looked at in the same way (reciprocity principle), and the parameters described below are equally valid for transmission and reception. This also applies if the parameters are in some cases measurable only for transmission or for reception or if their specification appears to be meaningful only for one of these modes (Johnson and Jasik, 1984), Active antennas are the only exception: being pure receiving antennas, they are non-reciprocal. Apart from that, a clear distinction between transmitting and receiving antennas must be made if, for example, the maximum transmitter power is to be taken into account. This is however irrelevant to the characteristics and the principle of operation..

i. Directivity Factor

The directivity factor D is defined as the ratio of the radiation intensity F_{max} obtained in the main direction of radiation to the radiation intensity F_i that would be generated by a loss-free isotropic radiator with the same radiated power P_t (Kennedy and Davis, 1993)**.** The radiation intensity can be replaced by the power density represented by the Poynting vector as shown in equation (1.0):

$$\underline{\mathbf{S}} = \underline{\mathbf{E}} \times \underline{\mathbf{H}} \qquad (1.0)$$

With **S** perpendicular to **E** and **S** and **E** perpendicular to **H** in the field

The power density is measured at the same distance r from the antennas (characters in bold and underlined characters in the above formula and in the following indicate vectors).

The following thus applies:

$$D = \frac{F_{max}}{F_t} \qquad (1.2)$$

Where $F_t = \frac{P_t}{4\pi}$ (1.3)

ii. Gain

An isotropic radiator is a hypothetical lossless antenna that radiates its energy equally in all directions. This imaginary antenna would have a spherical radiation pattern and the principal plane cuts or any plane cut would both be circles

The gain defined above is based on ideal matching and is determined from the practical gain and the magnitude of the reflection coefficient r according to the following formula:

$$G = G_{pract} \frac{1}{1.|r|^2} \qquad (1.4)$$

Gain and directivity factor are often expressed on a logarithmic form

$G = 10 \log G$ (dB)

And

$d = 10 \log D$ (dB)

In some cases and contrary to relevant rules and standards, the gain is not specified with reference to an isotropic radiator or with reference to a direction different from the main direction of radiation. Inborderline cases it is common practice (although not quite to standard) is to specify the gain referred to the isotropic radiator with the pseudo unit dBi and that referred to the halfwave dipole with dBd (Ahmed A, 2009).

iii. Effective Area

The effective area A_w of an antenna is a parameter specially defined for receiving antennas. It is a measure for the maximum received power Pr that an antenna can pick up from a plane wave of the power density S:

The effective area of an antenna can be converted to the gain and vice versa by means of the Formula:

$$A_w = \frac{\lambda^2}{4\pi} G \quad (1.5)$$

iv. Antenna Radiation pattern.

The spatial radiation of antennas is described by means of radiation patterns (usually in the far field).

The radiation pattern or antenna pattern is the graphical representation of the radiation properties of the antenna as a function of space. This means that, the antenna's pattern describes how the antenna radiates energy out into space (or how it receives energy). It is important to state that an antenna radiates energy in all directions, at least to some extent, so the antenna pattern is actually three-dimensional (Balanis, C., 2005). It is common, however, to describe this 3D pattern with two planar patterns, called the principal plane patterns. These principal plane patterns can be obtained by making two slices through the 3D pattern through the maximum value of the pattern or by direct measurement. It is these principal plane patterns that are commonly referred to as the antenna patterns.

The terms *azimuth plane pattern* and *elevation plane pattern* are often used in discussions of principal plane patterns or even antenna patterns (Gorobets et al, 2013). The term *azimuth* is commonly found in reference to "the horizon" or "the horizontal" whereas the term elevation commonly refers to "the vertical". When used to describe antenna patterns, these terms assume that the antenna is mounted (or measured) in the orientation in which it will be used. The azimuth plane pattern is measured when the measurement is made traversing the entire x-y plane around the antenna under test. The elevation plane is then a plane orthogonal to the x-y plane, say the y-z plane (Gorobets et al, 2013).

The antenna patterns (azimuth and elevation plane patterns) are frequently shown as plots in polar coordinates. This gives the viewer the ability to easily visualize how the antenna radiates in all directions as if the antenna was "aimed" or mounted already. Occasionally, it may be helpful to plot the antenna patterns in Cartesian (rectangular) coordinates, especially when there are several side lobes in the patterns and where the levels of these side lobes are important. These coordinates are shown in fig 1 and fig 2

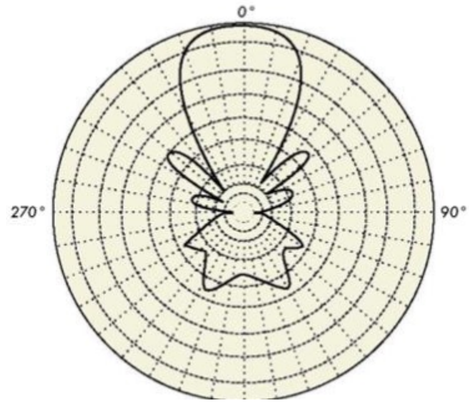

Fig 1: Radiation pattern in polar form

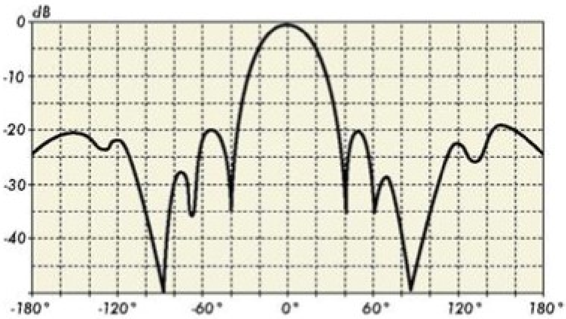

Fig 2: Antenna radiation pattern in Cartesian coordinate (rectangular form).

II. Review Of The Selected Antennas And Their Patterns

In this section, some common antennas are described along with details about typical patterns that can be expected from these common antennas. The antennas considered here are a dipole, a Yagi and a parabolic reflector. The patterns from each antenna are shown and explained in detail, including a 3D radiation pattern. The emphasis is on describing the patterns and the parameters that are derived from these patterns.

It is important to mention that it doesn't really matter in which direction the patterns are shown. The orientation of a particular pattern is often a matter of personal preference. The important goal of this section is to give the basic knowledge of what these antennas to do, so that one can understand the pattern parameters. Then the pattern's direction is of little importance.

The antenna input impedance strongly depends on the ratio of the antenna length to the wavelength so that considerable matching problems occur if the antenna is operated on another than its resonant frequency (Labade and Deosarkar S, 2010).

The radiation pattern also changes above a certain frequency as a function of the ratio of antenna length to the wavelength so that the main direction of radiation or the gain cannot be uniquely determined.

A. Dipole Antennas

A dipole antenna most commonly refers to a half-wavelength (λ/2) dipole. The physical antenna (not the package that it is in) is constructed of conductive elements whose combined length is about half of a wavelength at its intended frequency of operation.

The best known representative of this type is the tuned (halfwave) dipole shown in fig 3. It is made of infinitely thin and perfectly conductive material.

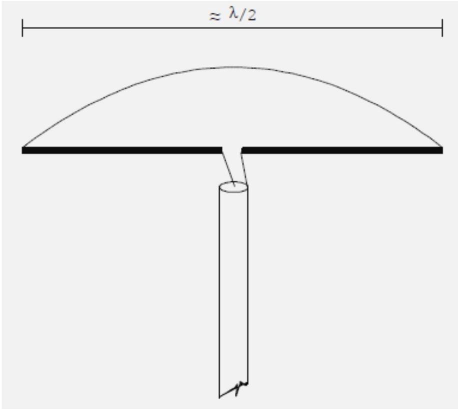

Fig 3: Tuned half-wave dipole

This is a simple antenna that radiates its energy out toward the horizon (perpendicular to the antenna) (Mohammad T., 2014). . The patterns shown in figure 3 are those resulting from a perfect dipole formed with two thin wires oriented vertically along the z-axis. The resulting 3D pattern looks kind of like a donut with the antenna sitting in the hole and radiating energy outward. . The strongest energy is radiated outward, perpendicular to the antenna in the x-y plane.

B. The Yagi Antenna

This antenna is made from materials with high electrical conductivity and reflecting ability. The antenna is very important because of its unidirectional pattern, high gain, broad bandwidth, higher terminal impedance, high directivity (Ochala and Okeme, 2011).

The directors can be made progressively shorter outwards to make the antenna taper in the direction of the transmitting antenna, making the antenna highly directive. Functionally, they direct electromagnetic energy towards the folded dipole, increasing the signal strength. Increasing their number and varying their lengths and spacing increase the directive gain and broad-band response of the antenna. They are usually shorter than the reflectors and act capacitively at high frequencies. (Labade and Deosarkar)

A typical Yagi antenna is shown in fig 4

Fig 4: A Yagi antenna. Source (Michael A et al, 2016)

C. The Parabolic Reflector Antenna

Long-distance radio communications (radio-relay links and satellite links), require high-gain antennas high-resolution radars, radio-astronomy, etc use parabolic reflector antennas. Reflector systems are probably the most widely used high-gain antennas (Yurduseven, O., 2011). They can easily achieve gains of above 30 dB for microwave and higher frequencies. Reflector antennas operate on principles known long ago from geometrical optics. The first RF reflector system was made by Hertz back in 1888 (a cylindrical reflector fed by a dipole). However, the art of accurately designing such antenna systems was developed mainly during the days of WW2 when numerous radar applications evolved.

The simplest reflector antenna is made of two components: a reflecting surface and a much smaller feed antenna at the reflector's focal point. More complex constructions involve a secondary reflector (a subreflector) at the focal point, which is illuminated by a primary feed (Chuan Liu et al; 2013). These are called dual-reflector antennas. The most common main reflector is the parabolic one. Other common reflectors are: cylindrical, corner, and spherical.

(i) Parabolic antenna focal length

One important element of the parabolic reflector antenna theory of operaton is its focal length. To ensure that the antenna operates correctly, the radiating element should be placed at the focal point which is determined from a knowledge of the focal length, f, given as (Chuan Liu et al; 2013).:

$$f = \frac{D^2}{16c} \qquad (1.6)$$

Where:

f is the focal length

D is the diameter of the reflector
c is the depth of the reflector

III. ANTENNA DESIGN METHODOLOGY

A. Introduction

In this chapter the design of the three antenna types considered for this work will be presented. The discussion will focus on the design methods, parameters and design assumptions and considerations.

The antenna is a critical component in a wireless communication system. A good design of the antenna can relax the system requirements and improve its overall performance. The thevenin equivalent circuit of a radiating transformer is shown in fig 5.

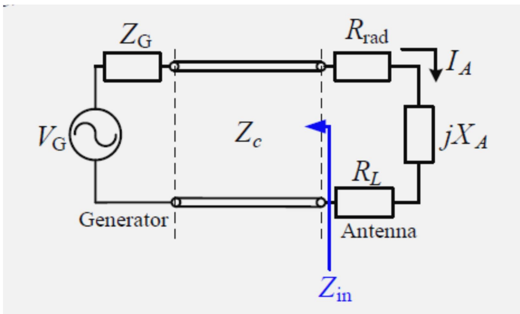

Fig 5: Transmission-line Thevenin equivalent circuit of a radiating (transmitting) antenna.

V_G = voltage source generator (transmitter)

Z_G = impedance of the generator (transmitter)

Z_C = the characteristic In=mpedance of the connecting TL

R_{rad} = radiation resistance (relates to the radiated power as $P_{rad} = I_A^2 x R_{rad}$

R_L = loss resisance (related to conduction and dielectric losses)

jX_A = antenna reactance

Z_{in} = input impedance of feed network as seen from antenna terminals

$Z_A = (R_{rad} + R_L) + jX_A$ (1.7)

One of the most important issues in antenna design is the matching of the antenna impedance to that of the transmission line (TL) and the generator ($Z_A = Z_{in}$). Matching is often measured in terms of the voltage standing-wave ratio (VSWR). Standing waves must be avoided because they may cause arching or discharge in the TL in high-power RF systems (radar, broadcasting). But the main benefit of good impedance match (with low VSWR) is the maximum power transfer from the transmitter to the antenna and vice versa

The resistive/dielectric losses, R_L , are not desirable either. They decrease the efficiency of the antenna. On the other hand, in special applications such as ultra-wideband (UWB) antennas in imaging and radar, the antenna resistance may be increased intentionally in order to improve the bandwidth and suppress “ringing” in the transmitted or received signals.

The equivalent circuit of a receiving antenna is shown in figure 1.6

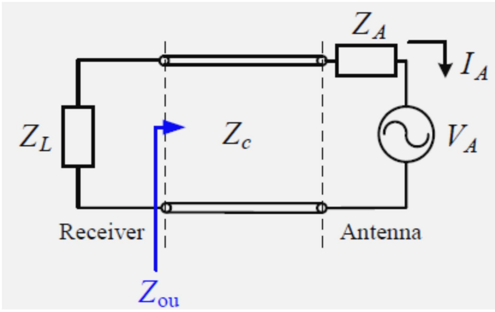

Fig 6: transmission line Thevenin equivalent circuit of a receiving antenna

Z_{ou} = output impedance of the antenna-plus-feed network, which serves as a signal generator as seen from the receiver terminals Zou

B. Parabolic reflector design

A feed horn for 2,79 GHz center frequency, , focal length of 14.4mm and a parabolic dish diameter of 26.9mm has been considered in this project. A parabolic reflector is entirely defined by three basic parameters: the antenna center frequency, the diameter of it aperture D, and the focal length of the reflector, f.

The industrial practice is to use the f/D ratio to specify the shape of the parabolic reflector and the diameter D of its aperture. For any given parabolic reflector, the focal length f is directly obtained by multiplying its f/D ratio by its diameter D. In this work the variations of these parameters relative to one another were studied and presented.

The basic and very general structure of a parabolic reflecting surface with feed antenna or complete parabolic antenna is shown in Fig 7. The parabolic antenna designed is made up of a feed antenna which pointed backwards to the reflecting surface, and is often a horn or a waveguide (Wade P, 1998) The tool used to simulate the design is Computer Simulation Technology tool which is a 3D electromagnetic simulation software.

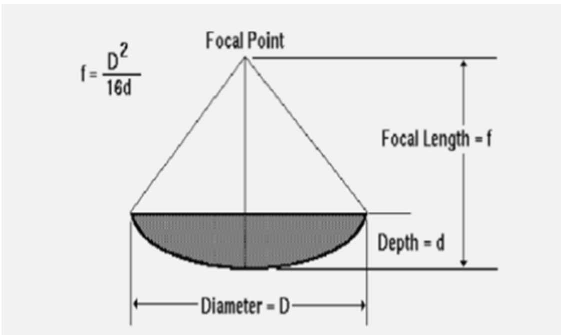

Fig 7: mathematical diagram of parabolic reflector

The following formulas are useful for designing a parabolic reflector. The derivation of the formulas are given in Appendix: Derivation of Equations and Formula

In designing a parabolic reflector, it is often convenient to use its depth d instead of its focal length. The formula for obtaining the depth is

$$d = \frac{D^2}{16f} \qquad (1.8)$$

Conversely, given a parabolic dish and its measurements for the diameter D and the depth d, then its focal length f is obtained with

$$f = \frac{D^2}{16D} \quad (1.9)$$

In table 1 frequencies are varied while the focal length and diameters are kept constant. Frequency variation does not affect efficiency but give sharper beam width with varying frequency to produce better beam width.

Table 1: constant focal length and diameter and variable frequency.

Frequenct (GHz)	**Focal length (m)**	**Diameter (d)**	**Efficiency Ŋ = f/D**	**Beam width ψ= 70λ/D**
2.79	22.4	26.9	0.83	0.27
3.00	22.4	26.9	0.83	0.26
3.25	22.4	26.9	0.83	0,23
3.50	22.4	26.9	0.83	0.22
3.75	22.4	26.9	0.83	0.21

In table 2 focal lengths are varied while the frequency and diameter are kept constant. Focal length variation does not affect beam width but produce a better efficiency according to requirement.

Table 2: Constant frequency and diameter and variable focal length

Frequenct (GHz)	**Focal length (m)**	**Diameter (d)**	**Efficiency Ŋ = f/D**	**Beam width ψ= 70λ/D**
2.79	22.4	26.9	0.83	0.27
2.79	20.4	26.9	0.75	0.27
2.79	18.4	26.9	0.68	0.27
2.79	16.4	26.9	0.60	0.27
2.79	14.4	26.9	0.53	0.27

In table 3, diameters are varied while the frequency and focal length are kept constant. Diameter decrement affects both the efficiency and beam width increase but produce a poor result according to requirement.

Table.3.constant frequency and focal length and variable diameter

Frequenct (GHz)	**Focal length (m)**	**Diameter (d)**	**Efficiency Ŋ = f/D**	**Beam width ψ= 70λ/D**
2.79	22.4	26.9	0.83	0.27
2.79	22.4	24.9	0.89	0.30
2.79	22.4	22.9	0.97	0.32
2.79	22.4	20.9	1.07	0.35
2.79	22.4	18.9	1.18	0.39

C. Dipole antenna design

In this work, a simple half-wave dipole antenna has been designed and analyzed for wireless applications. Resonant frequency for the dipole antenna was 5 GHz and CST Microwave Studio (MWS) has been used to simulate the design. The simulation was used to analyse the return loss curve, the VSWR and the far field radiation patterns of the half-wave dipole antenna.

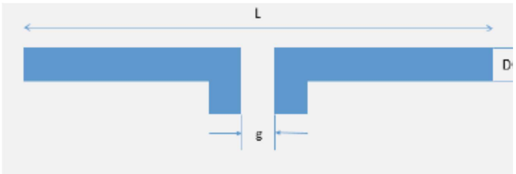

Fig 8: Half-wave dipole antenna

A general construction of a half-wave dipole antenna (Saunders et al, 2007) is shown in the Fig 8. There is a gap between two arms of half-wave dipole antenna for feeding purpose. Here L is the total length of the antenna, D is the thickness of antenna arm and g is the feeding gap. Radiation resistance of the half-wave dipole is 73 Ohm which matched with the line impedance (Balamis et al, 2005).

(i) Design Parameters

Dimension of an antenna changes based on the resonant frequency. As a resonant frequency of 5GHz has been chosen, by taking this into consideration several antenna dimensions have been calculated as follows:

Resonant frequency $f_r = 5GHz$

Wavelength $\lambda = \frac{c}{f} = (3\,x10^{11}) + (5\,x10^{9}) = 60mm$ Length of half wave dipole antenna $L = \frac{143}{f} = 28.6\,mm$

Feeding gap of the antenna

$g = \frac{L}{200} = \frac{28.6}{200} = 0.143\text{mm}$

Radius of the wire $R = \frac{\lambda}{1000} = \frac{60}{1000} = 0.06mm$

All dimensions of the antenna are given in the Table 4

Table 4: Design parameters of the dipole antenna

Parameter	Value	Unit
Resonant Frequency (fr)	5	GHz
Wavelength λ	60	mm
Impedance	73	Ohm
Length of the dipole (L)	28.6	mm
Radius of the dipole (R)	0.06	mm

A summary of the results from the simulation is presented in table 5.

Table 5: Simulated results of the designed dipole antenna

parameter	Value	Unit
Resonant Frequency (fr)	4.922	GHz
Bandwidth	0.54983	GHz
Directivity	2.195	dBi
Gain	2.149	dB
Return Loss	-58.6498	dB

D. Yagi antenna design

The design parameters for an FM wave Yagi antenna operating at a frequency of 106 MHz are given in the table 5.

Table 5: Yagi antenna construction parameters.

Element	Value	Unit
Reflector	1.41	Meters
Driven Element	1.35	Meters
First Director	1.30	Meters
Second Director	1.26	Meters
Length of boom	1.25	Meters

The Yagi antenna is a narrow-band antenna designed to work only on FM channel. It optimised to have the best gain for its sizes and a correspondingly narrow main lobe (beam).

The Yagi antenna designed has a dipole as the main radiating or driven element. Further 'parasitic' elements are added which are not directly connected to the driven element. These parasitic elements pick up power from the dipole and re-radiate it. The phase is in such a manner that it affects the properties of the RF antenna as a whole, causing power to be focused in one particular direction and removed from others. The parasitic elements of the Yagi antenna operate by re-radiating their signals in a slightly different phase to that of the driven element. In this way the signal is reinforced in some directions and cancelled out in others. It is found that the amplitude and phase of the current that is induced in the parasitic elements is dependent upon their length and the spacing between them and the dipole or driven element.

There are three types of element within a Yagi antenna as shown in Fig 9

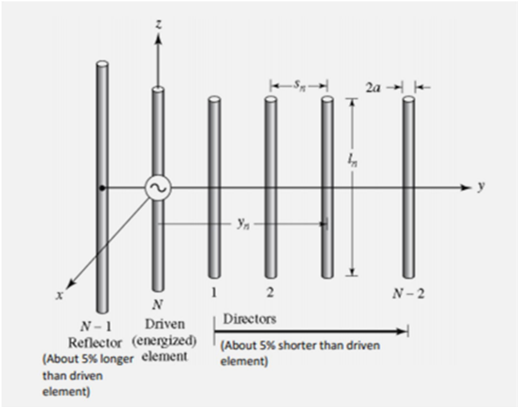

Fig 9: the elements of a Yagi antenna and their typical configuration.

IV. Result Analysis

A. Half -wave dipole antenna analysis

For the simulation purpose the ranges of frequencies have been chosen from 4 GHz to 6 GHz for the half-wave dipole antenna. The simulation results showed that the antenna resonated at 4.992 GHz. Moreover, the value of return loss has been found as -58.65 dB (approx.).

The return loss was observed from the simulation and the return loss curve is as shown in fig 10.

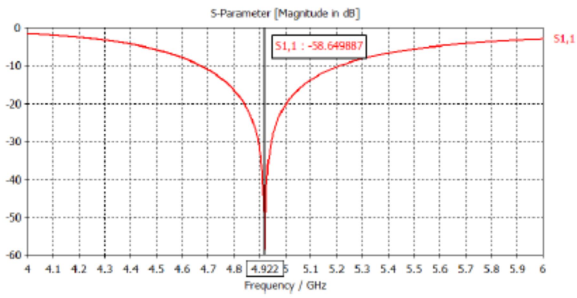

Fig 10: Return loss curve for the Half-wave dipole antenna.

Bandwidth of the antenna is shown in the Fig 12. From the simulation result, the bandwidth of the designed antenna was found to be 0.54983 GHz. Ranges of frequency at -10 dB are 4.6667 GHz and 5.2165 GHz.

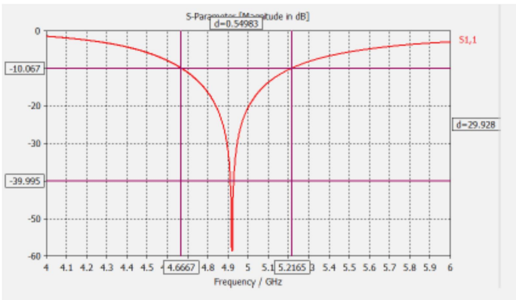

Fig 12: Bandwidth curve for the Half wave dipole antenna.

VSWR curve has shown in the fig 13. This was found to be 1.2 at the resonant frequency 5GHz.

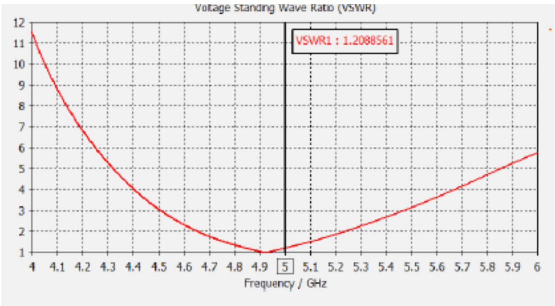

Fig 13: VSWR Plot of the designed half wave dipole antenna

. Directivity was found as 2.195 dBi. The directivity obtained from the simulation was very close to the theoretical ones found in literatures (Johmson and Jasik, 1984). Red color shows areas with the maximum radiation.

The radiation patterns are shown in polar form in fig 14.

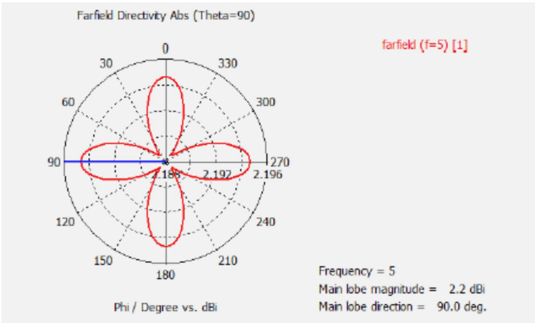

Fig 14: polar plot for Azimuthal Angle of the Designed half wave dipole antenna.

A polar plot for the azimuthal angle is shown in fig 15

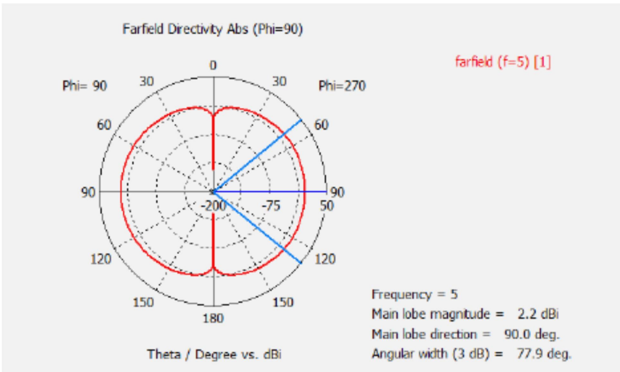

Fig 15: a polar plot for the elevation angle of the half-wave dipole antenna designed

The input impedance is specified as Z=R+jX, where R is the resistance and X is the reactance. Note that for very small dipole antennas, the input impedance is capacitive, which means the impedance is dominated by a negative reactance value (and a relatively small real impedance or resistance). As the dipole gets larger, the input resistance increases, along with the reactance. At slightly less than 0.5λ the antenna has zero imaginary component to the impedance (reactance X =). And the antenna is said to be resonant.

If the dipole antenna's length becomes close to one wavelength, the input impedance becomes infinite. This wild change in input impedance can be understood by studying high frequency transmission line theory.

The peak directivity of the dipole antenna varies with the length of the dipole as shown in fig 16

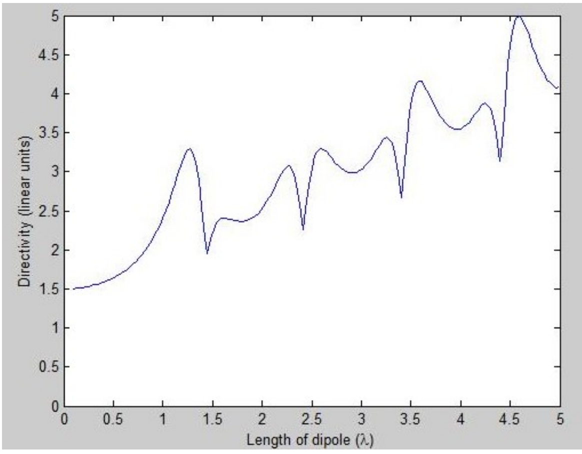

Fig 16: Peak directivity of the dipole antenna vs the length of the dipole

The figure indicates that up until approximately L = 1.25λ, the directivity increases with length. However, for longer lengths the directivity has an upward trend but is no longer monotonic.

B. Yagi antenna analysis

The analysis was done to identify the effects of each element on the performance of antenna with the aim of achieving a high gain.

The directivity of the Yagi antenna can be obtained in the same way as for the simple dipole. Although there is a variation between different designs and the way Yagi-Uda antennas are constructed, it is possible to place some very approximate figures for anticipated gain against the number of elements in the design. The approximate Yag-Uda antenna gain level is paramount to its characterization. A simple estimation of the maximum directivity of a Yagi-Uda antenna could be obtained as follows: D = 10Log3.28N (dB), Where N is number of elements in its boom (Labade and Deosarkar, 2010) The coefficient 3.28 results from doubling the directivity (1.64) of a half-wave dipole. Since there are N elements, the maximum is obtained when they are combined constructively as 3.28N. The reason for introducing the factor of 2 is that the radiation pattern is now unidirectional end-fire. The radiation is redirected to just half of the space by the reflector and directors, which is somewhat similar to the effect of conducting ground plane. For the simple three-element Yagi-Uda antenna designed, N=3. Therefore, D=3.28(3) and D=9.93dB. When the number is doubled to N=6, additional gain can be obtained as D=12.94dB in (Mukta, B. 2007)

As an additional rule of thumb, once there are around four or five directors, each additional director adds around an extra 1dB to the directive gain of the antenna. This is clearly seen in the gain for directors up to about 14 or more. It is interesting to know that with 25 numbers of elements, the achievable gain is just 19.14dB. The gain increases with the increasing number of directors as shown in Fig 17. Since there is no appreciable increment in the gain, it is therefore economical to keep the number of directors to the allowable minimum as postulated in (Htung and Boyle, 2001)

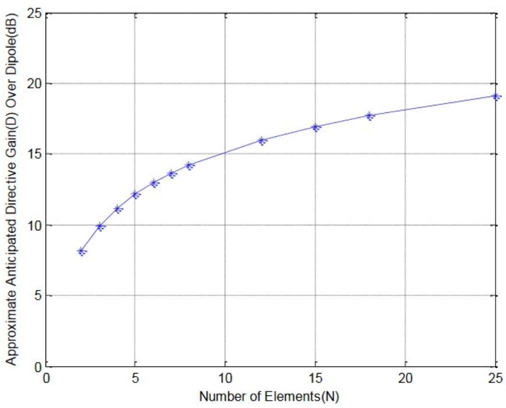

Fig 17: Graph of Directivity Gain versus Number of elements

Depending on the spacing of the reflector and director elements, a Yagi-Uda antenna will display lobes to a greater or lesser extent in its radiation pattern. The spacing will therefore determine the size and number of rear-lobes present in the entire radiation pattern. One of the figures associated with the Yagi-Uda antenna gain is what is termed the front to back ratio, F/B. This is a ratio of the signal level in the forward direction to the reverse direction and normally expressed in dB.

C. Parabolic reflector antenna analysis

In this research the analysis of the parabolic reflector parameters like f/D, gain, radiation patterns has been done and the corresponding results were plotted and presented. The E-plane and H-plane normalized radiation patterns in dB of parabolic reflector were calculated and then the beam width and efficiency were calculated by using general formulas presented in this work. The calculations made in this analysis were based on the center frequency of 2.79GHz, focal length of 14.4mm and a parabolic dish diameter of 26.9mm

The E-plane normalized radiation patter for such antenna is shown in fig 18.

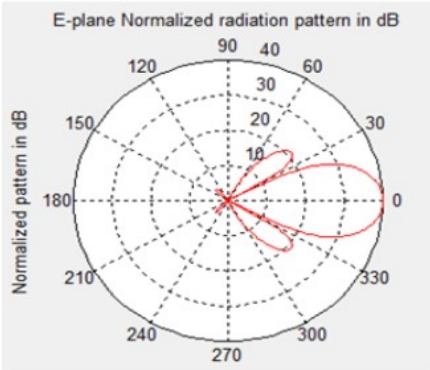

Fig 18: E- plane normalized radiation pattern

The radiation pattern produced by the feed is called the primary pattern and that radiated by the aperture is called secondary pattern. The total pattern of the system is represented by the sum of the secondary pattern and the primary pattern of the feed element. For most feeds (such as horns), the primary pattern in the bore sight direction of the reflector is of very low intensity and usually can be neglected.

V. Conclusion And Recommendation

The fundamental antenna concepts and a brief introduction to the types of antenna have been discussed. Three antenna prototypes along with their basic specifications have been verified at specific operating frequencies and their design details were presented in the document. The reflector antenna, Yagi antenna and the half wave dipole antenna were designed, simulated and tested. From both the simulation result and the experimental results various characteristics and parameters of these antennas were studied.

An analysis of the parabolic reflector characteristics like f/D, gain, radiation patterns has been done and the corresponding results were plotted. The primary radiation patterns of the horn feed was calculated and then its far field pattern was calculated by using general and aperture approximation methods. From results it can be concluded Horn feed has more intensity and more directivity than either the square or dipole feeds. Using Aperture approximation it was possible to achieve more intensity and more directivity than general method.

To further this study on parabolic reflector antenna design, the basic reflector design can be extended to a dual polarized antenna. Hence, if developed, dual polarized will have vast and promising applications in the ISM / WLAN industry globally (Ochala and Okeme, 2011).

For the Half wave dipole antenna, obtained results were acceptable for practical implementation of this types of antennas. The obtained resonant frequency (4.992 GHz) was lesser than target frequency (5 GHz) which is acceptable. Return loss obtained as -58.6498 dB which shows the characteristic of reflection coefficient. Bandwidth was observed as almost 550 MHz which is good enough to cover various wireless applications. In the future, researchers can work to improve the results by optimizing several parameters of the antenna.

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