Design and Simulating Horn Fed Parabolic Reflector Antenna

Somayajula Eswara Chaitanya PG Scholar, Dept. of Electronics and communication Engineering, Andhra University College of Engineering, Andhra University, Visakhapatnam.

P. V. Sridevi Professor, Dept. of Electronics and communication Engineering, Andhra University College of Engineering, Andhra University, Visakhapatnam

Abstract:

Now a days horn antennas are developed and role of its application being raised continuously. The Parabolic reflectors also widely used in Microwave range applications. Simulation & optimization, In HFSS, horn fed parabolic reflector will be used. The modelling of a metal horn antenna fed into a metal parabolic reflector, along with the observation of many aspects corresponding gain, directivity, radiation pattern, VSWR, and S parameters, is the major goal of this project. ANSYS HFSS 15.0 is used to simulate the horn-fed parabolic reflector antenna. This innovation's application area encompasses parabolic reflectors with input from horn antennae.

KEYWORDS: high-frequency structural simulator (HFSS), Ansys HFSS, parabolic reflector, horn, gain, radiation.

I.**INTRODUCTION**

The antenna is a metallic communication tool used in electronics and communication. A communication system needs an antenna to function. In addition to receiving slightly incoming electromagnetic waves and converting them into electric signals, antenna is utilized to convert electrical signals into electromagnetic waves and transfer them into open space. They are designed for wireless communication and have the capability to propagate both radio and microwave signals. Basically, it is fair like a conductor and the resonant device, which works on a very narrow frequency band. Furthermore, to receiving or transmitting energy, antennas in sophisticated radiocommunication systems frequently have to enhance or emphasize the radiated energy in some directions and reject it in others. So, apart from being a probing tool, the antenna must also function as a pointing device.

Antenna has unique name, namely messenger. Antennas are used in numerous fields for example defense applications such as radar and missile testing, aerospace applications such as satellite and space communications, and universal communications such as mobile communications, television and broadcasting, and many more. Then it must take various forms to meet specific needs and can be a section of conducting wire, opening, patch, array of elements (matrix), reflector, lens, etc.

The antenna area is alive and dynamic, and antenna technology has been a vital partner in the communications revolution for the past sixty years. Several significant developments produced during this time are still in use today. However, we are now confronting more problems and obstacles, owing to increased system performance expectations.

II. **HORN ANTENNA**

Horn Antenna is an Aperture Antenna. Due to the rising need for more complex types of antennas and the use of higher frequencies, aperture antennas might be more well-known to the general public nowadays than in the past. This kind of antenna may be attached flush to the surface of an aero plane or spacecraft, which makes it particularly convenient for usage in these applications. They can also be wrapped in a dielectric substance to shield them from potentially dangerous environmental conditions. The Pyramidal Horn is the kind of horn that is utilized.

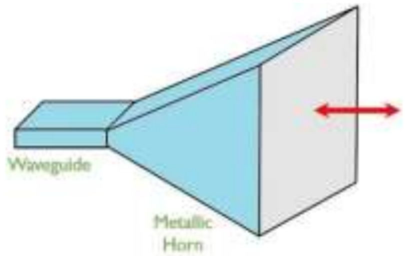

Figure 1: Horn Antenna

III. PARABOLIC REFLRCTOR ANTENNA

The Successes in space research led to the further development of theory of antenna. As of the necessity to communicate over long distances, complex antenna shapes must be used to transmit and receive signals that must travel millions of miles. A very common form of antenna for such applications is the parabolic reflector antenna. This type of antenna is built with a diameter of 305 m or even larger. Such massive dimensions are essential to provide the high gain required to send or receive signals after millions of kilometers of travel. The angular reflector is another type of reflector, though it is not as common as a parabolic mirror.

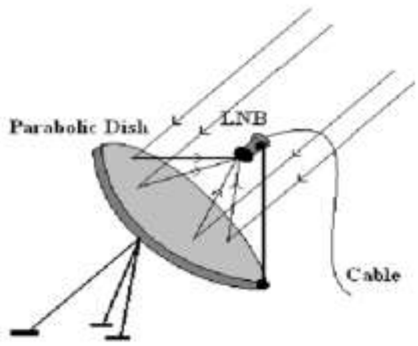

Figure 2 Parabolic Reflector Antenna

IV. DESIGNING AND SIMUATION

The horn and the parabolic reflector are the two components that comprise the horn-fed parabolic reflector antenna design. Before we begin, we will assume that the system's operational frequency will be 9GHz and that the overall system output gain will be 15dB. Antennas may need to accommodate complex dual-frequency, multifunctional operation, physical and mechanical constraints, specific electrical, thermal, and environmental requirements, as well as high gain and narrow beamwidth, depending on the application.

The following are the formulas required to create a horn antenna:

- $A=0.45\lambda\sqrt{G}$
- $B = (G\lambda^2)/(4\pi*0.51A)$
- $R_1 = A^2/3\lambda$
- $R_2 = B^2/2\lambda$
- $R_E = R_2(1-(a/A))$
- $R_H = R_1(1-(b/B))$

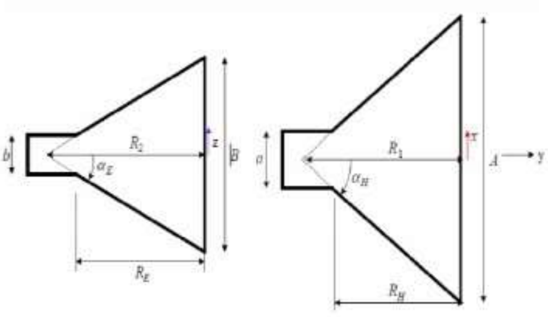

Figure 3: Design of Horn Antenna

It is a demanding topic of research to design parabolic reflector antennas. Antennas may need to accommodate complex dual-frequency, multifunctional operation, physical and mechanical constraints, specific electrical, thermal, and environmental requirements, as well as high gain and narrow beamwidth, depending on the application.

Below is the formula needed to design a parabolic reflector:

- Deriving Diameter using Gain Formula
- $G = 10 \log_{10} K \left(\frac{\pi D}{\lambda}\right)^2$ => D
- Focal length = $D^2/16D$
- Bandwidth = $f_H - f_L$
- Beamwidth = $\frac{70\lambda}{D}$

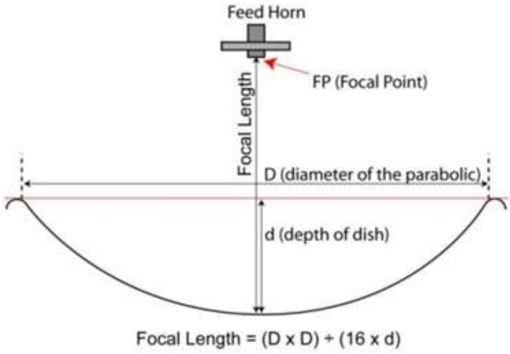

Figure 4: Design of Parabolic Reflector

With recent advancements in communication technologies, antenna designs are growing more sophisticated. Sorting out the software that is best suited to our needed antenna design is crucial these days. Without the use of these programs, referred to as electromagnetic solvers, complex antenna systems cannot be simulated. The accuracy of the results, the runtime, and the ability to simulate electrically huge structures are crucial simulation factors. High Frequency Structure Simulator, a well-known electromagnetic solver, is one of the most well-liked ones (HFSS)

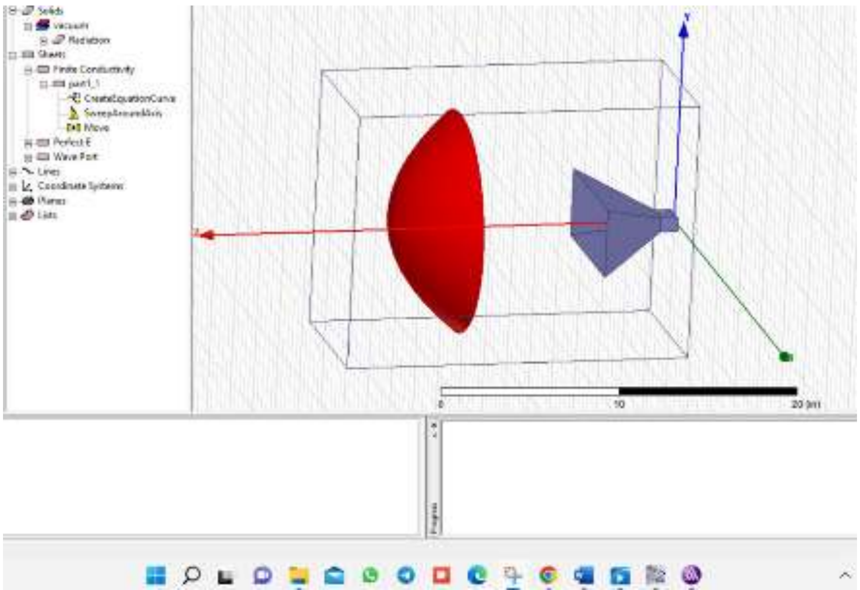

Figure 5 Design of Horn Fed Parabolic Reflector

V. RESULTS ANALYSIS

Based on the designed model, numerous output parameters were analyzed and obtained. The most important output parameters are VSWR, S11, Gain and Radiation Pattern.

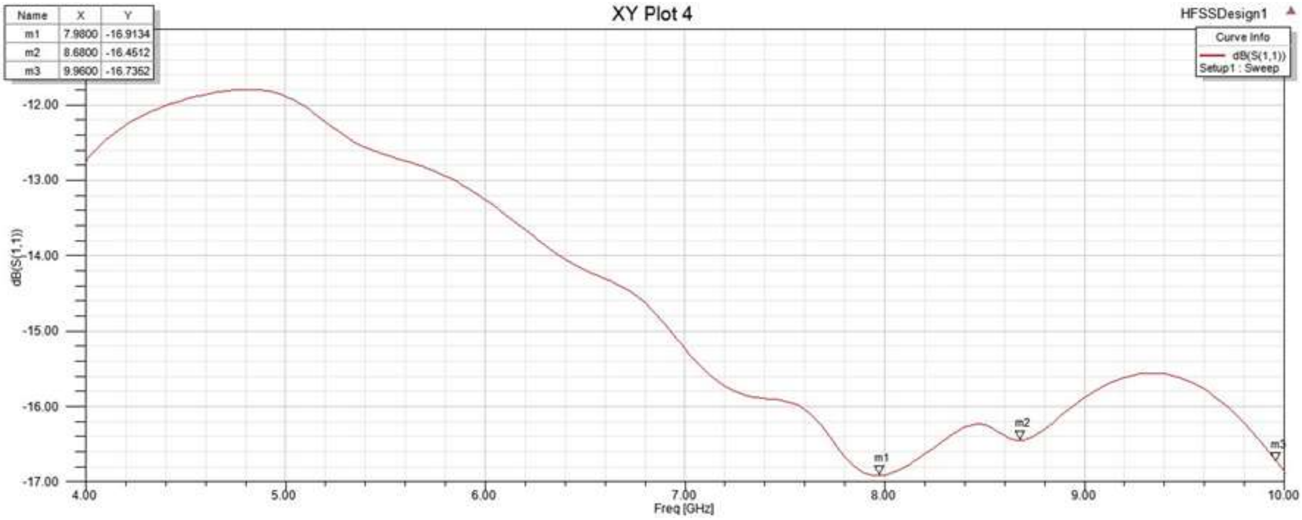

Figure 6: reflection coefficient (s_{11}) Graph of Parabolic Reflector Antenna with Horn feed

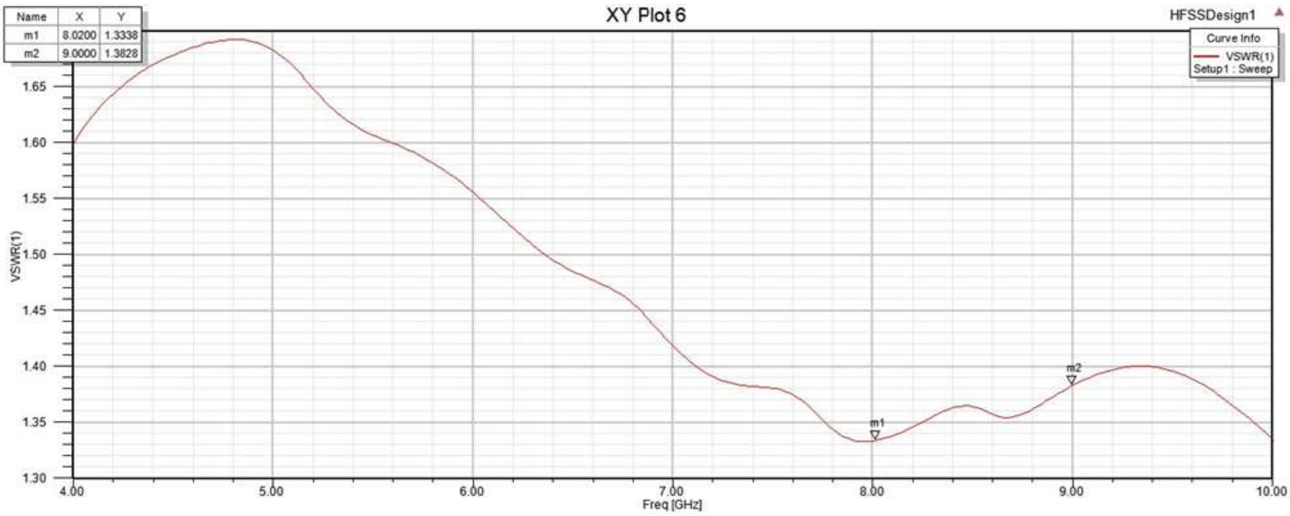

Figure 7: Graph of VSWR of Parabolic Reflector Antenna with Horn feed

Figure 8: 3D polar plot of Gain of Parabolic Reflector Antenna with Horn feed

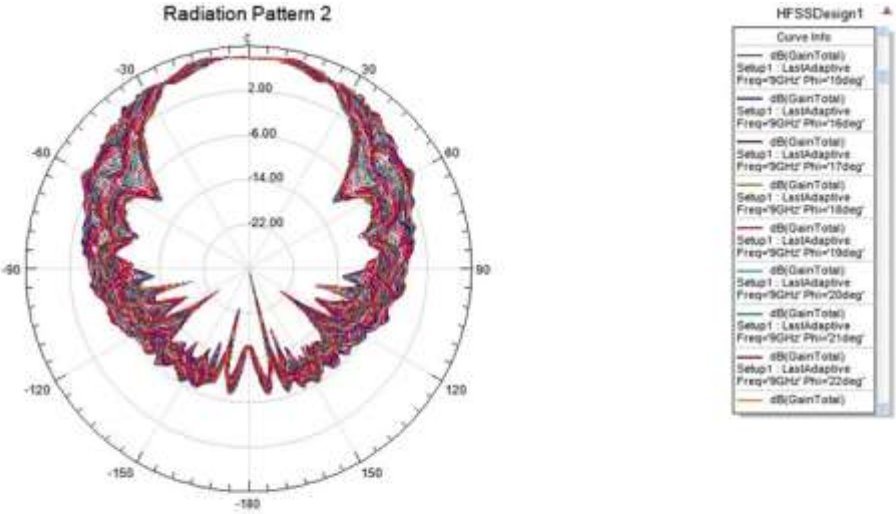

Figure 9: Radiation Pattern of Parabolic Reflector Antenna with Horn feed

The findings of simulation analysis allow us to conclude that the designed antenna was able to produce the gain and radiation for which it was intended more effectively.

VI. **CONCLUSION**

Antenna design and simulation is a challenging discipline. We achieved excellent results by developing a horn feed parabolic mirror antenna founded on various efficiency factors and simulating it on ANSYS HFSS. Analysis of outcomes helps us to draw conclusions. We anticipate that the horn-fed dish antenna will be more efficient when utilized in an application based on an examination of the major parameters. Parabolic antenna design is a difficult skill to master. Depending on the application, the antenna may need to provide high gain and a narrow beamwidth while also meeting complex dual frequency, multimode operation, physical and mechanical restrictions, electrical thermal, and unique environmental requirements. The designer must anticipate and consider the influence of all of these factors and their interactions on antenna performance. The antenna feed is the most critical component of the design. India has created a high gain narrow beam parabolic reflector antenna using unique design and analytical approaches for missile radar altimetry, angle tracking, and high data rate communications. These projects have contributed significantly to the success of missiles such as the Agni series missiles, Prithvi series missiles, Brahmos series missiles, Astra, Advanced Air Defense (AAD), Anti-Radiation Missiles and Anti-Satellite Missiles. Many more unrivaled and unrivaled rockets could be developed in the future.

The Horn Fed Parabolic Reflector Antenna is designed, modelled, and tested at a frequency of 9 GHz, with the outcomes being shown in the Ansys HFSS program. According to the results, the Horn fed Parabolic Reflector Antenna has a return loss of -16.9 dB, which is a minimum loss for all working frequencies. Additionally, the VSWR achieved is 1.33, which is a better value; the acceptable VSWR value should not be higher than 1.5. For a 9 GHz working frequency, the gain is 8.69 db. For Phi values between 0° and 180°, the radiation pattern for antenna gain is observed. Finally, it is concluded that the Horn fed Parabolic Reflector at 9Ghz has provided superior performance, and suitable for using in real time applications .

The future Scope For this Antenna is Developing the Antenna to operate at more higher Frequencies by Changing the Reflector models for obtaining better performance.

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