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# Performance Evaluation of Conformal Patch Antenna

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**Abstract:** *In recent years, there has been a great deal of interest in conformal antennas in both industry and science. In fact, this field of study now occupies the top of the research pyramid of many national research institutes. According to the latest market analysis report, conformal antenna sales are estimated to exceed $ 3 billion in 2017 and $ 300 billion in 2028. In addition, conformal antennas are attractive candidates for next-generation consumer electronics due to their lightweight, low manufacturing costs, ease of manufacture, and availability of inexpensive flexible substrates (paper, fiber, plastic, etc.). Flexible electronic systems i.e., conformal antennas, also include flexible antennas that provide additional room for system trade-offs and design flexibility. This type of antenna is designed for conformal antenna applications. The simulation work was performed using HFSS software which is a finite element procedure, and the antenna size was determined. The performance of the conformal antenna, including reflection attenuation, radiation pattern, gain and return loss was measured and the simulated results were found to be in good agreement with the simulated results of the standard antenna.*

**Keywords:** Reflection attenuation, radiation pattern, HFSS, gain, return loss

## I. INTRODUCTION

Conformal antennas are widely used in mobile communication systems, radar systems, and aerospace applications, especially because they are lightweight, thin, and easy to manufacture. It is often used in equiangular arrays because of its ability to conform to non-planar structures. The compliant array antenna allows for an integrated non-obtrusive design and can provide good coverage. The surface on which the element is mounted often affects the radiation characteristics of the array, and it is important to be able to predict such fluctuations. However, the complex shape and geometrics can cause costly problems. In this paper, we are presenting a method by showing how to analyze the performance evaluation of an array of rectangular microstrip patch antenna which is surface-mounted or embedded in a multi-layer cylindrical structure. Initially, a standard microstrip patch antenna is designed with length(L)-29.44mm, breadth(B)-38mm, resonant frequency(fr)-2.4Ghz, dielectric constant-4.4, dielectric height(h)-1.6mm and an impedance of 243 ohms is obtained. A conformal antenna is designed by embedding a curved antenna into a cylinder of dimensions. These antennas are compared based on their radiation pattern, gain, and return loss to know the most efficient antenna among them.

## II. LITERATURE SURVEY

The conformal antennas have been divided into two categories, singly and doubly curved, depending on the number of curvatures the geometry of the antenna has. This patch antenna is confined only for biomedical and designed in a particular pattern. The antenna position will be carried out, to obtain the conclusion that the broader beam is achieved for full coverage. It is directly linked to the project ANASTASIA i.e., Air bone New and Advanced Satellite Techniques and Technologies in A System Integrated Approach. This designs a conformal antenna according to most of the ARINC (Aeronautical Radio, Inc.) specifications. Complex geometries lead to elaborate problems and long-time EM simulations.

The array configurations of the conformal antennas play an important role in the general conformal antenna study. Curvature's effect on the quantity of reflection attenuation and radiation pattern of flexible printed wires and disc monopole antennas was explained. For additional antenna flexibility, the Ts = 0.254 mm option is ideal. Because the curvature of the beam axis impacts the radiation behavior, a disc monopole antenna is preferred over a wire monopole antenna. A conformal antenna provides a wide coverage angle, and compact size and can be conformed to any shape. It is used for creating a conformal antenna with zero phase shift and zero-time delay which modifies it from basic array antennas. It helps in preventing aerodynamic drag and hydrodynamic drag. Using the HFSS simulator, this project comprises the blueprint for planar antennas that will be carved into the exterior metallic layers of ships and aircraft.

The design and analysis of the performance of a split-ring resonator-filled conformal antenna on a cylindrical exterior have been carried out. A split-ring resonator enhances the gain characteristics. It helps to learn the process of designing a GPS antenna of low contour and better performance. The demerit of this process is better performance is not possible with antennas of larger dimensions. The antenna is designed using several microstrip pieces in X range frequency which can be combined along with the structure of the host and is discrete to the man's eye. For printed wire and disc antennas, this describes the effects of curvature on both return loss and radiation pattern.

It provides a wide coverage angle and random is not required so it eliminates minor losses. The material can elevate the gain and the bandwidth with better radiation properties of the antenna. It can be created for carrying out multiple applications on an appliance.

A conformal microstrip patch antenna consequent E and U-shaped aperture are created to function at triple-band frequencies of 2.057 GHz, 3.6102 GHz, and 6.2624 GHz. This conformal structure with shortened corners is used for circular polarization. This antenna is simulated by using the HFSS microwave studio finite element package. All the simulated parameters like return loss, directivity, gain, and radiation pattern. There exist critical variations between the blueprint considerations for instances of narrowband vs. ultrawideband and the unique impulse array conditions. Strong discontinuities or gradients of impedance produce substantial reflections of incident signals. The curvature has a positive effect on a microstrip antenna's fringing field, and as a result, it affects the effective dielectric constant and other antenna characteristics. These parameters were developed utilising two different substrates, K-6098 Teflon or Glass and Epsilam-10 Ceramic-Filled Teflon products, in TM01 mode. Simple insertion and the ability to incorporate the model within complex aerodynamic exteriors, good angular analysis, and stable gain, which is dependent on the shape are only a few of the advantages of conformal antennas over planar microstrip structures.

Breast Hyperthermia is autoimmune cancer therapy, wherein the breast is slightly heated by an electromagnetic (EM) light to kill the cancer cells. A textile antenna is proposed, consisting of a radiating splotch and a ground plane composed of copper-covered and woven polyester cloth. Polyester is employed as a dielectric material as well as a stuffing layer.The spongy nature of the fabric enables a thin antenna which results in minimal dielectric deprivation. A wearable conformal patch antenna that would conform to the body contour is designed which works differently than the rigid nature of PCB materials.

## III. ANALYSIS AND SIMULATION

The proposed designed antenna is simulated using 'Ansys 2021 R2'. To find the parametric change from a planar microstrip antenna to a conformal antenna, a cylindrical surface is considered and used as the reference surface. Firstly, a planar surface microstrip patch antenna with a line feeding mechanism is simulated. the microstrip patch designed in the plane surface is then wrapped onto the cylindrical surface with the help of a thickened ground plane. Finally, we simulate the required parameters by adjusting the design accordingly to compare and conclude the aim of the simulation.

## IV. RESULTS AND DISCUSSION

**Objective 1:**

Collecting two different patch antennas and simulating them

To compare and analyse, the required tools for this project are the planar standard microstrip antenna and curvature conformal patch antenna. Collecting both the antennas and differentiating them in terms of the radiation pattern, gain, and return loss.

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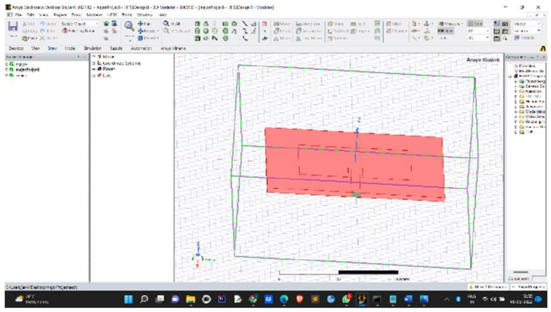

Fig.1. Microstrip Patch Antenna in HFSS

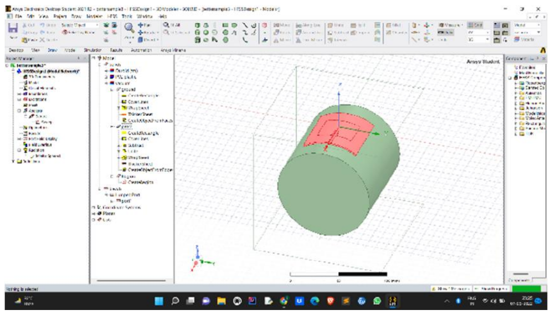

Fig.2. Conformal Patch Antenna in HFSS

**Objective 2:**

Differentiating the radiation patterns between the planar and curvature antennas

Different antennas have different radiation patterns with respect to the shape, size, and angle of radiation. Similarly, for both planar and curvature antennas, the radiation pattern is different and on basis of the efficiency and maximum radiation pattern, the antenna is valued.

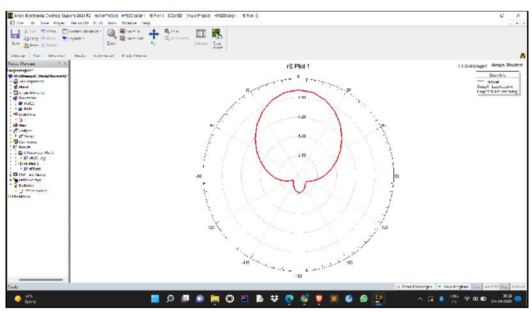

Fig.3. The radiation pattern of the planar antenna

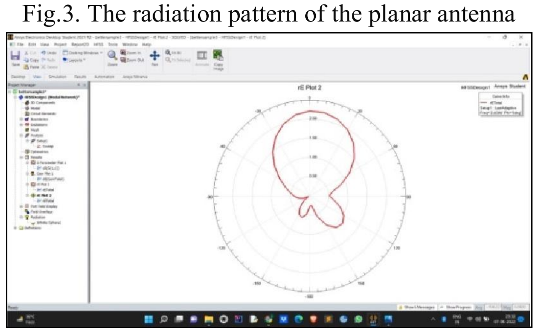

Fig.4. The radiation pattern for the conformal antenna

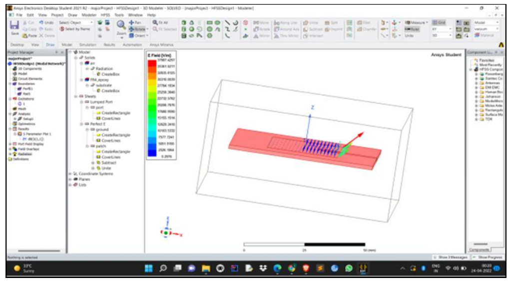

Fig.5. Electric Field of the planar antenna

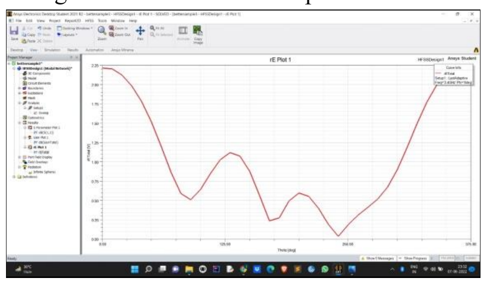


Fig.6. Electric Field of conformal antenna

**Objective 3:**

Calculating the gain of both the antennas

Simulating and calculating the gain of both antennas. This is done in order to determine how well the antennas convert input power into radio waves traveling in a specific direction.

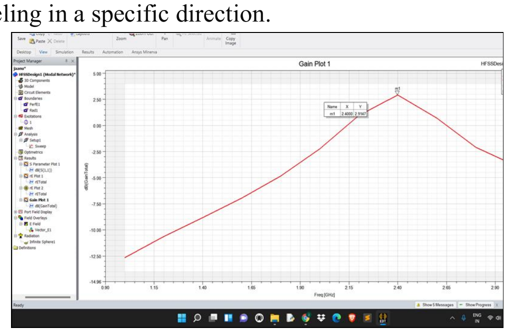


Fig:7 The gain curve of the planar antenna is shown in Figure 7.

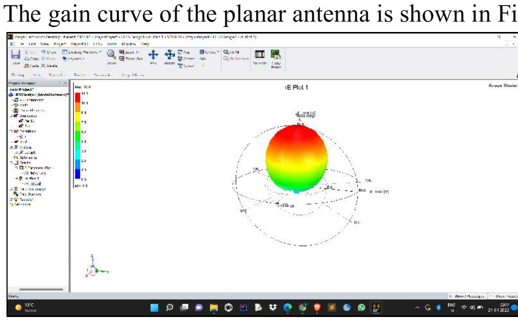


Fig.8. 3-D Polar plot of the planar antenna

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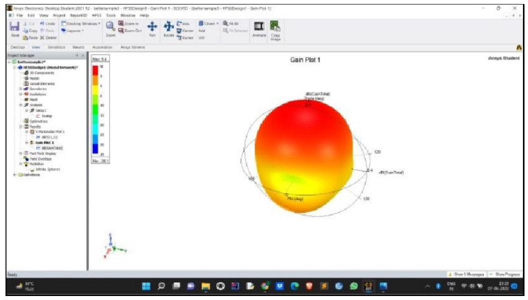

Fig.9. The 3-D Gain plot of conformal antenna

**Objective 4:**

Finding out the return loss compared to each antenna and calculating efficiency

To calculate the efficiency and to check the return of incident radiation waves and the number of waves that are rejected by the antenna depicts the return loss. So, the higher the return loss, the higher the efficiency, and return loss is calculated.

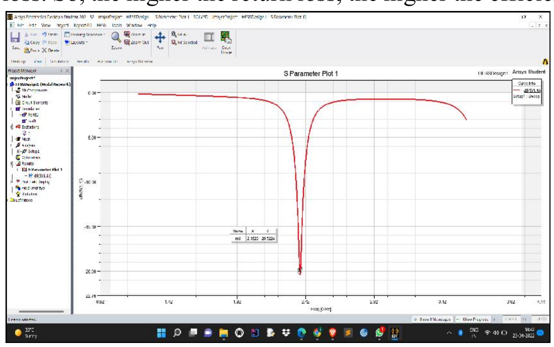

Fig.9. The planar antenna's return loss

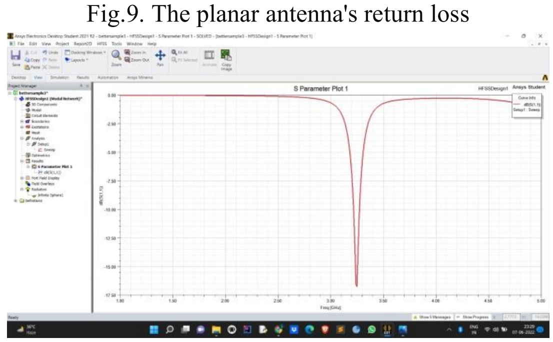

Fig.10. The return loss of the conformal antenna

## V. CONCLUSION

We intend to design and analyze the conformal patch antenna and compare it with the standard microstrip patch antenna. The comparison is done on the basis of three factors, they are, radiation pattern, gain and return loss of an antenna. An antenna with an omnidirectional radiation pattern has been achieved. Conformal arrays are limited to high frequencies in the UHF or microwave range because the elements must be small. The wavelength is small enough for the small antennas to be used. They have a vital impact on communication and navigation applications on aircraft, ships, and other vehicles.

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