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Research Paper

Gain Enhancement of Helical Antenna.

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Abstract: Helical antennas are widely used in satellite communications as they provide circular polarization. High gain helical antennas are essential for satellite applications. Helical antenna is also used as feed for a parabolic dish to acquire higher gains. In this paper the gain of the helical antenna is increased by reducing the space between turns .The antenna is designed and simulated at 176.4MHz in *MATLAB 2017B.*

Key Words: Helix, parabolic dish, gain, directivity, CST, Flame retardant-4(FR-4).

1. Introduction

Helical antenna was introduced by John D. Kraus in 1946 **[1]-[8]**, also known as unifilar helix **[2].**This type of antenna consists of a single wire or a wire wound on a dielectric shaft in the shape of right hand or left hand screw **[3].**Helical antenna is fed by a coaxial line over a small ground plane with diameter D and the other end of the wire is left as open circuit. Helical antennas are widely used in earth base stations in satellite communications systems **[5].** Helical antennas can be operated in normal mode and axial mode. Axial mode helical antennas offer circular polarization without using polarizer .So, they are widely used in satellite and RADAR communication system applications. Helical antennas provide wide band width and higher gain as compared to Micro strip antennas **[1].** But higher gain is required for RADAR and Space communication applications. In the past various methods and techniques are proposed to improve the gain of a helical antenna. The main motto of this paper is to increase the gain by reducing the size.

2. Antenna configuration and design approach

Figure 1 shows the helical antenna configuration which we have taken. The antenna configuration is fed by 50 Ω coaxial cable. Helical antenna design parameters are given in table-1. The antenna is fed by a generator connected at the antenna base, between the antenna and the ground plane. The feed is located at the base of this segment. In this paper, we consider that the antenna operates only in the axial mode. Helical antennas can be mounted on various types of conductors such as infinite ground plane, square ground conductor, cylindrical cup and truncated cone. In this paper in order to increase the gain, helical antenna is mounted on circular cylindrical conductor (figure -1).In this paper Uniform helices (constant pitch (p)) are assumed. The number of helix turns is N. The diameter of the circular disc over which the axis of the helical conductor is wrapped is D=2πr, where r is the corresponding radius. The helix conductor can be a tube or wire. In this paper, we assumed only conductors with a circular cross section, whose radius is r. The helical antenna is often mounted on a conducting ground plane. The plane could be very large or be on the order of one wavelength. Only the first case is assumed in this paper. We considered that the helix is located in a vacuum **[2].**

Table-1: Helical antenna design parameters

Geometry - helix	
Radius	0.36046
Width	0.01442
Turns	3
Spacing	0.5045
WindingDirection	CCW
FeedStubHeight	0.001
GroundPlaneRadius	1.0816
Tilt	0
TiltAxis	[1 0 0]

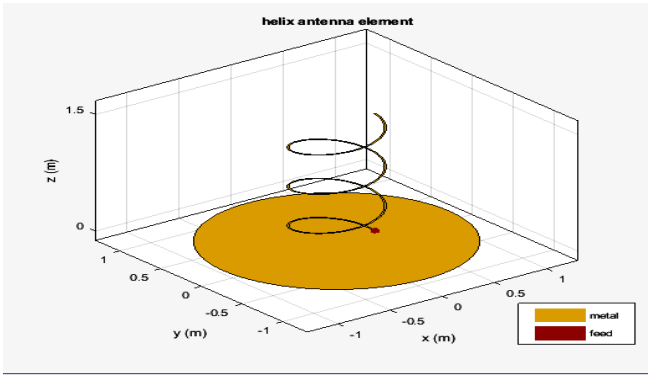

Figure 1: Helical antenna

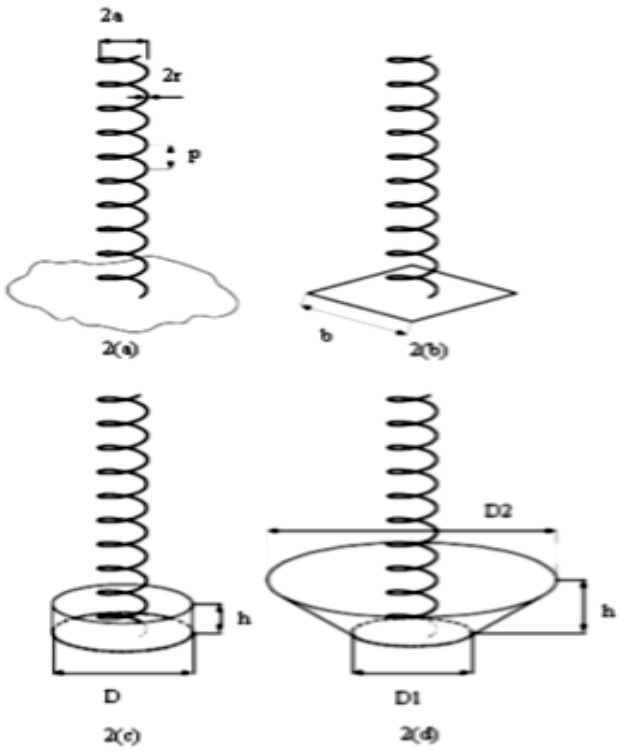

Figure 2: 2(a) - antenna over infinite ground plane. 2(b) - antenna over square ground conductor 2(c) - antenna over cylindrical cup 2(d) - antenna over truncated cone.

3. Simulation results

The proposed antenna is designed and simulated in *MATLAB* at 176.4MHZ .Directivity is nothing but maximum gain obtainable in a particular direction. All practical antennas are directive, .i.e. they are designed to radiate in one specific direction. It indicates that they concentrate the gain of that antenna in that specific direction. The physical values of both gain and directivity are almost same. Mathematically, they are related by only one factor, the efficiency. Efficiency lies between 0 and 1. Gain is a product of efficiency and directivity. No difference between gain and directivity for a lossless antenna. If lossy, efficiency factor will come in this case we have assumed a loss less antenna, hence, gain is almost equal to directivity. In Figure 4 S_{11}=-37 dB represents that all the power is reflecting from the designed antenna and negligible amount is radiated. As spacing between helix turns is reducing the gain of the antenna is increased .Highest gain is obtained when spacing between helix turns is 0.5045m.As spacing is increasing the reduction in gain and directivity is observed .From figure 6 it is observed that the proposed antenna provides 11.1 dBi gain .Hence the proposed antenna is a good choice for Space and *RADAR* communication system.

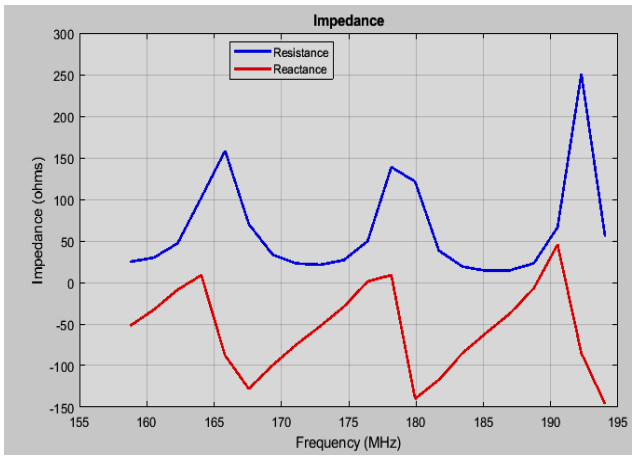

Figure 3: Impedance Vs Frequency Curves

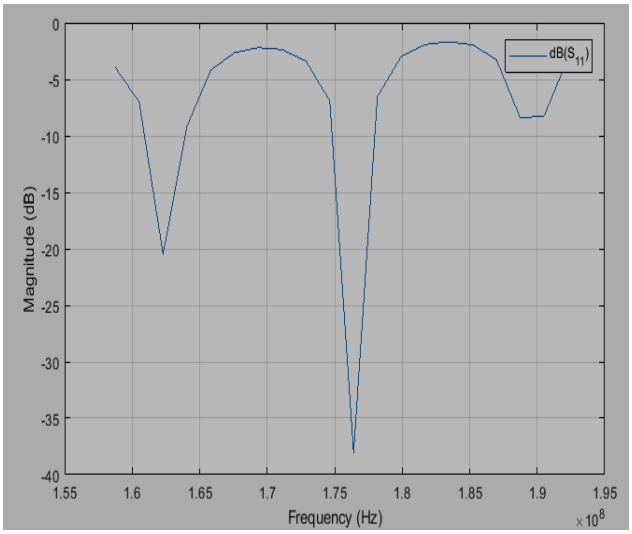

Figure 4: Return Loss of designed helical antenna

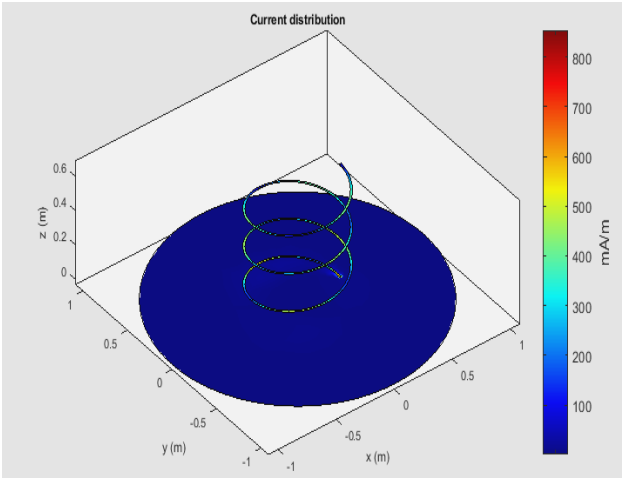

Figure 5: Current distribution of the proposed antenna

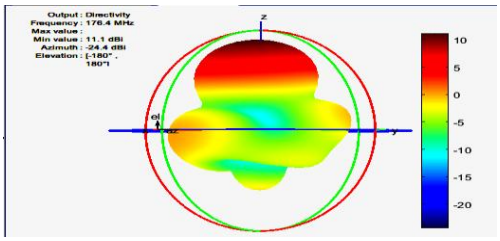

Figure 6: Directivity of the proposed helical antenna

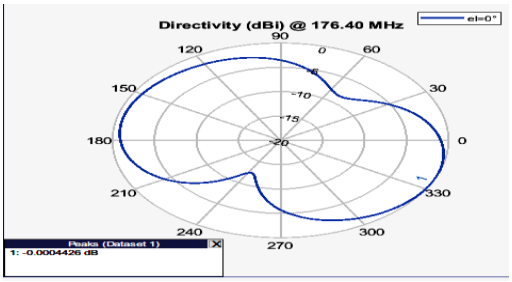

Figure7: Azimuth of the proposed antenna

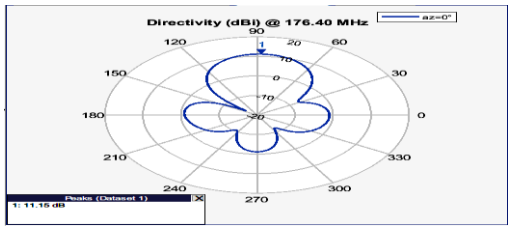

Figure 8: Elevation of the proposed antenna

4. Conclusion

In This paper a helix is developed over circular disk conductor. The main purpose of this paper is to increase the gain of helical antenna reducing the spacing between the turns of helix. Form simulation results it is observed that as the spacing between the turns decreasing the gain of antenna was increasing. Further the size of the antenna was decreasing with the decrease in turn spacing.

5. Future scope

We can further improve different parameters of the axial mode helical antenna at various bands, such as Return loss, Directivity, input impedance and *VSWR*.

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