Gain Enhancement of the Helical Antenna by Effecting TurnSpacing

Yazdan Khan[1], Ashish Kumar*[2], Jayant Sharma[3]

[1](Department of Electronics and Communication,Shoolini University, Solan,India)

[2](Department of Electronics and Communication,Shoolini University, Solan,India)

[3](Department of Electronics and Communication,Shoolini University, Solan,India)

E-mail - ashish.thakur.243@gmail.com

***Abstract*—Helical antennas have been widely used as simple and practical radiators over the last few decades. The reason of this demand is that, these antennas are having remarkable and unique properties such as naturally providing circularly polarized radiation and also they have been so much popular in applications from VHF to microwaves requiring circular polarization, especially in case of satellite communications where more gain is required and that can be provided by adopting a helical antenna alone, a helical antenna can also be used as a feed for a parabolic dish for higher gains. As compared to the microstrip antenna, helical antennas are having a large bandwidth. Although gain of helical antenna is sufficient for communication purpose, but for applications like satellite communication, space communication etc., these antennas require high gain. The antenna performance is optimized by varying antennas geometrical parameters for narrowband and broadband design. So in this paper we have tried to increase the gain of helical antenna by decreasing the spacing between the turns of coil. Calculation and measurement for this new antenna have been done with the help of software MATLAB and also from HELICAL ANTENNA DESIGN CALCULATOR. In this paper by effecting the turn spacing we are able to increase the gain by 8.75% successfully.**

***Key Words*—Antenna gain, antenna length, helical antennas.**

I. INTRODUCTION

The Helical antenna was discovered by John Kraus in 1946. These antennas have been known for a long time[1]-[8]. Helical antennas are also called as unifilar helix[2], due to the reason that, such kind of antennas are consists of a single wire or narrow tape wound like a right hand or left hand screw, self supporting or wound on a dielectric cylinder[3]. Generally helical antenna is excited by a coaxial line over a small ground plane with diameter D and the other end of the wire is left as open circuit. These helical antennas are having many applications in communication system, when there is a need of broadband circular polarized antennas. These antennas are also having applications in the satellite communications systems [5], where these antennas are mostly used at earth based stations. There are two modes of helical antennas i.e. normal mode and axial mode. Axial mode helical antennas are of considerable interest in satellites and radars because they provide circular polarization over a wide bandwidth without the use of any kind of polarizer. These antennas are having various advantages over the microstrip patch antennas, such as the bandwidth of these helical antennas are wide and also gain is high[1]. But in case of space communications radar and other applications there is a need of much higher gain.

In this paper we are going to study how to increase the gain of helical antennas. Although there are number of methods has already well defined in case of improvement in gain. But our main purpose is to increase the gain of helical antenna and also to reduce its size i.e. also to reduce the length of this antenna. Hence we adopted this method.

II. ANTENNA CONFIGURATION AND DESIGN APPROACH

A. Basic Helix Antenna Configuration

Figure 1 show a helix antenna configuration which we have taken. The geometry of this type of antenna model configuration is fed by 50 Ω coaxial cable. This antenna is consists of one hollow dielectric cylinder with relative permittivity 2.1 and diameter 61.33mm. 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 assume that the antenna operates only in the axial mode.

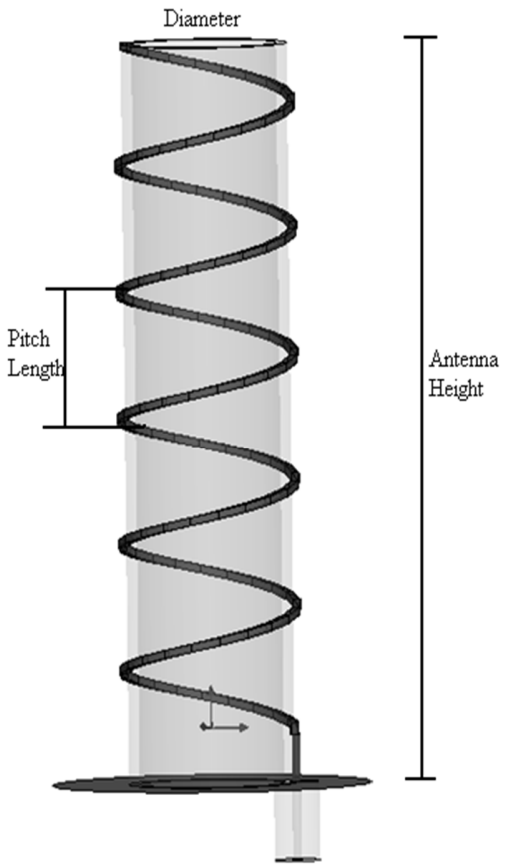

Figure 1: Sketch of a basic helical antenna.

B. *Helical Antenna Over Various Types of Conductors*

There are various types of conductors over which helical antenna can be placed[6]. Figure 2 shows four types of antenna configuration over different conductor planes i.e. antenna over infinite ground plane, antenna over square ground conductor, antenna over cylindrical cup and antenna over truncated cone. But in order to increase the gain of helical antenna we used the configuration in which antenna is located over the square ground conductor.

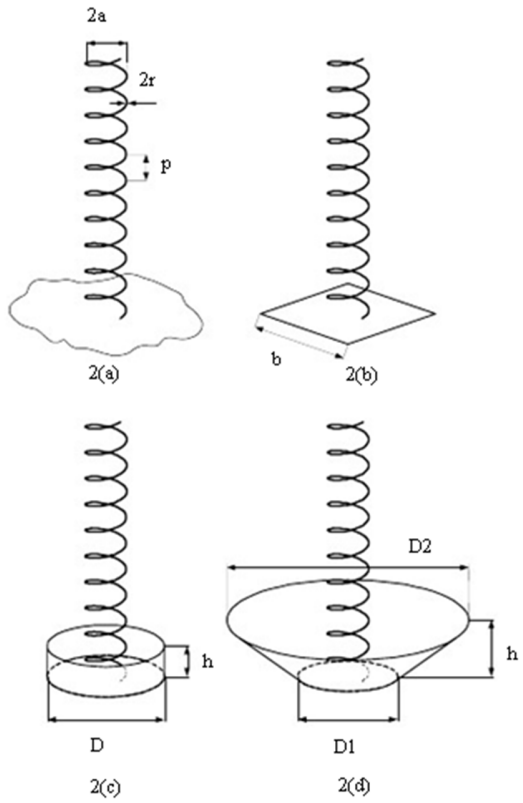

Figure 2: 2(a) - antenna over infinite ground plane.
2(b) - antenna over square ground conductor
2(c) - antenna over cylindrical cup
2(d) - antenna over truncated cone

C. *Antenna over Square Ground Conductor*

Only uniform helices, i.e., helices with a constant pitch (p), are considered in this paper. The number of helix turns is N. The diameter of the imagined cylinder over which the axis of the helical conductor is wrapped is $D=2a$, where a is the corresponding radius. The helix conductor can be a tube or wire. In this paper, we shall consider only conductors with a circular cross section, whose radius is r. The helical antenna is often located above a conducting ground plane. The plane can be very large (theoretically infinite) or be on the order of one wavelength (finite dimensions). Only the first case is considered in this paper. We assume that the helix is located in a vacuum [2].

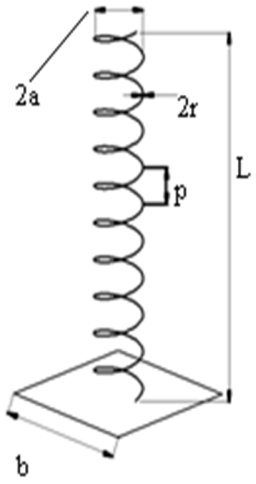

Figure 3: Antenna over square ground conductor.

There are various basic geometrical parameters that define a helical antenna. Table 1 summarizes these various parameters.

Table 1: Various parameters of helical antenna

Quantity	Symbol	Relation to basic Quantities
Helix radius	A	-
Helix diameter	D	D = 2a
Circumference	C	C = 2πa
Pitch	p	-
Pitch angle	A	α = arctan (p/C)
Number of turns	N	-
Antenna length	L	L = Np
Wire radius	r	-
Square ground plane side	B	-

III. CALCULATION OF GAIN OF HELICAL ANTENNA

To find the electrical characteristics of a helical antenna, besides the geometrical parameters, we need to know the operating frequency (f) or the frequency band (B). [1]The lower edge of the operating frequency band is f_{min} and the upper frequency band is f_{max}.. The central frequency is defined as[7] : $f_c = \square f_{min} - f_{max} \square / 2$

Also the formula for the gain is given below[9].

$$g_{[dBi]} = 10\,log\left(15\left(\frac{C}{\lambda}\right)^2 \frac{L}{\lambda}\right)$$

Let us suppose the designing frequency is 1700 MHz; so by varying the turn spacing we can increase the gain of helical antenna as shown below.

Table 1: Calculations of Various parameters of helical antenna

Turn Spacing N*λ	0.24	0.23	0.22	0.21	0.20	0.19	0.18
Wave-length (mm)	176.4	176.4	176.4	176.4	176.4	176.4	176.4
Ideal Diameter (mm)	61.3	61.3	61.3	61.3	61.3	61.3	61.3
Gain (dB)	14.64	14.84	15.05	15.27	15.49	15.73	15.98
Conductor Diameter d (mm)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Winding Step (mm)	42.3	40.5	38.8	37.0	35.2	33.5	31.7
Adapter Separation (mm)	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Conductor Length (mm)	2764	2759	2754	2749	2745	2741	2736
Reflector Diameter (mm)	109.4	109.4	109.4	109.4	109.4	109.4	109.4
Antenna Length (mm)	592.9	568.2	543.5	518.8	494.1	469.0	444.7

We can also observe from the table that conductor length and antenna length is also getting affected by the decreasing value of turn spacing i.e. antenna length is also becoming small. So this new method of improving gain of helical antenna also helps us to make a compact size antenna.

IV. REPRESENTATION OF GRAPHS

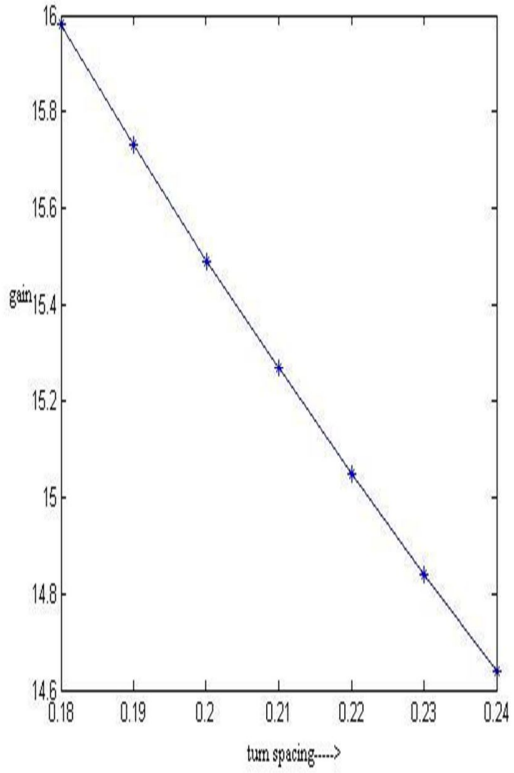

Figure 4: Graph between turn spacing Vs gain

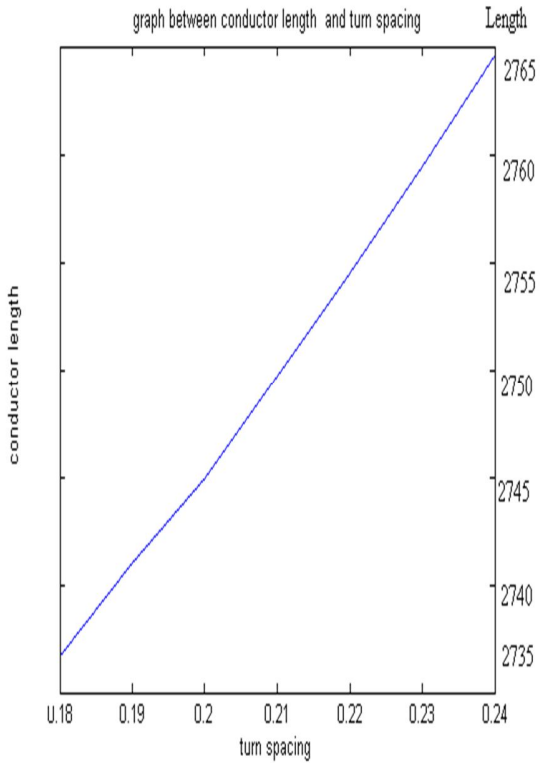

Figure 5: Graph between turn spacing Vs Conductor length

V. CONCLUSION

We took a helix antenna which is placed over square wave conductor. As our goal was to increase the gain of helical antenna, hence we reduced the turn spacing between the helix turn. As the turn space was decreasing the gain of antenna was increasing. Also the length of conductor and length of antenna was decreasing with the decrease in turn spacing. If we calculate by how much amount is it increased? The result comes out to be 8.75%. We can also the graph which are shown in figure 4 and 5 that how the turn spacing affects the gain and length of conductor and length of antenna.

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BIOGRAPHY

Mr. Yazdan Khan received an M.Tech degree in ECE from Jodhpur National University, Rajasthan and B.Tech degree in Electronic and Communication Engineering from Amravati University, Maharashtra, India in 2002. He is having 11 years of experience in teaching and industrial at various reputed organizations. Now he is currently working as a Assistant Professor in Shoolini University, Solan, (H.P). His current research interest in the area of Antenna & its Wave Propagation, Microwave Engineering and Optical Fiber Communication. He has published 1 research paper in an International Journal.

Mr. Ashish Kumar is a student. He is pursuing his bachelor's degree in Electronics & Communication Engineering from Shoolini University, Solan (H.P). His research interest is in the field of Microstrip Antenna, Helical Antenna and VLSI circuits. He has published 1 research paper in an International Journal.

Mr. Jayant Sharma is a student. He is pursuing his bachelor's degree in Electronics & Communication Engineering from Shoolini University, Solan (H.P). His research interest is in the field of wireless communication and MIMO Technology.