# Composite Design of Novel Helical Antenna

S.Saranyadevi, R.Mohanapriya
*PG Scholar, Assistant Prof*
*Paavai Engineering College, Namakkal*

***Abstract:***

*In this paper, we proposed the design process and the deployment mechanism of a quadrifilar helix antenna presented. The antenna are proposed to operate in the UHF frequency band. They are composed of conductors that are embedded and supported by innovative structural techniques. This allows efficient folding, packaging and deployment once in space. The conductors in the quadrifilar helix antenna are composed of Brass and copper. The new aspects of these designs lie in their structures and deployment mechanisms. A comparison is executed between both designs and their potential deployment possibility from CubeSats is also investigated.*

## I. INTRODUCTION

Antennas are a very important component of communication systems. By definition, an antenna is a device used to transform an RF signal, traveling on a conductor, into an electromagnetic wave in free space. Antennas demonstrate a property known as *reciprocity*, which means that an antenna will maintain the same characteristics regardless if it is transmitting or receiving. Most antennas are resonant devices, which operate efficiently over a relatively narrow frequency band. An antenna must be tuned to the same frequency band of the radio system to which it is connected, otherwise the reception and the transmission will be impaired. When a signal is fed into an antenna, the antenna will emit radiation distributed in space in a certain way. A graphical representation of the relative distribution of the radiated power in space is called a *radiation pattern*.

The helical antenna is a hybrid of two simple radiating elements, the dipole and loop antennas. A helix becomes a linear antenna when its diameter approaches zero or pitch angle goes to $90^o$. On the other hand, a helix of fixed diameter can be seen as a loop antenna when the spacing between the turns vanishes ($a = 0^o$).

Helical antennas have been widely used as simple and practical radiators over the last five decades due to their remarkable and unique properties. The rigorous analysis of a helix is extremely complicated. Therefore, radiation properties of the helix, such as gain, far-field pattern, axial ratio, and input impedance have been investigated using experimental methods, approximate analytical techniques, and numerical analyses. Basic radiation properties of helical antennas are reviewed in this chapter.

The geometry of a conventional helix is shown in Figure 1. The parameters that describe a helix are summarized below.

$D$ = diameter of helix
$S$ = spacing between turns
$N$ = number of turns
$C$ = circumference of helix = $pD$
$A$ = total axial length = $NS$
$a$ = pitch angle

If one turn of the helix is unrolled, the relationships between
$S, C, a$ and the length of wire per turn, $L$ , are obtained as: $S = L \sin a = C \tan a$

$$L = (S^2 + C^2)^{1/2} = (S^2 + p^2 D^2)^{1/2}$$

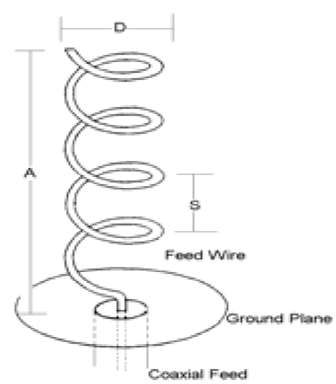


**Fig.1 Geometry of helical antenna**

The monofilar helix antenna was invented in 1946 by John Kraus. Few antennas are as easy to construct as Kraus' original monofilar helix. Some form of support, a "pie-pan" ground plane of any diameter between ½-1 wavelength, some simple impedance matching and a single conductor wound according to a few simple rules yields a circularly polarized antenna capable of 10-17 dBi gain over 60% fractional bandwidth. Feedpoint impedances, depending on the feed geometry, will be of the order 150-300 ohms (depending on antenna geometry), therefore some form of impedance matching will be needed for efficient operation in 50 ohm systems. Helix windings and circular polarization are always described as "right-" or "left handed." Keeping this straight is important, but not difficult using the "right-hand" and "left-hand" rules.

In this paper, we proposed the design process and the deployment mechanism of a quadrifilar helix antenna They are composed of conductors that are embedded and supported by innovative structural techniques. This allows efficient folding, packaging and deployment once in space. The conductors in the quadrifilar helix antenna are composed of Brass and are supported by helical arms of S2 glass fiber reinforced epoxy.
The rest of this brief introduces the concept based on helix antenna in the section I and the related works are presented in Section II. Then, in Section III, the proposed methology is presented. Section IV presents a experimental Results and Section V presents a performance analysis to illustrate the effectiveness of the approach. Finally, the conclusions are summarized in Section VI.

## II. RELATED WORKS

There was a conductive composite tape-spring is presented for CubeSat deployable antennas that is constructed using a glass fiber reinforced epoxy with an embedded copper alloy conductor. The tape-spring is bistable enabling the antenna to be elastically stable in both the deployed and stowed states. A dipole antenna is designed, simulated, and tested to prove the viability of the electrical properties of this material.

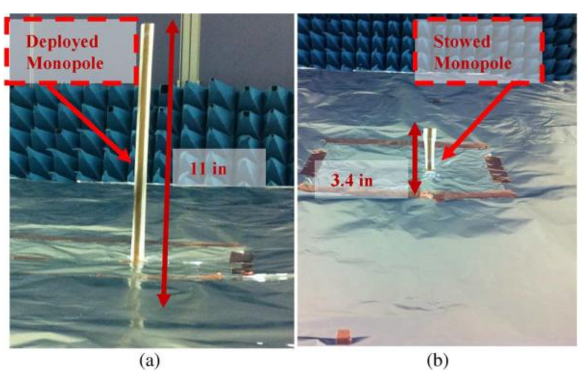


**Fig.2: (A) Deployed And (B) Stowed Monopole Above the Ground Plane**

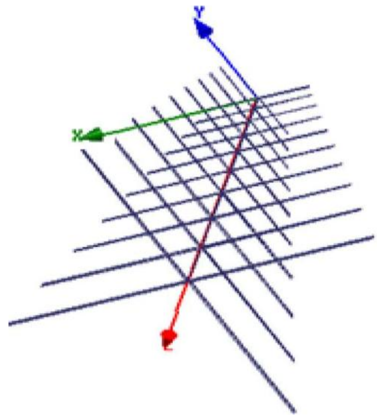

**Fig 3: Composite Tape-Spring Log-Periodic Crossed-Dipole Antenna Array Concept.**

Using the bistable composite tape-spring discussed previously, we design a dipole to operate at 250 MHz. To reduce the simulation processing time in the high frequency structuresimulator by ANSYS (HFSS), the material is assumed to be of rectangular shape and not curved.We also assume the Brassembedded in the middle has a width of 0.25 in. The total width of each dipole arm is 0.5 in. The total dipole length is found to be equal to 22 in, which is equivalent to at 250 MHz. A zoomed-in view of the curved antenna with the actual material is used. The simulated dipole with the approximated tape-spring with a zoomed-in view of its excitation. The measurement of this dipole is done by using the image Method, A composite tape-spring quarter-wavelength monopole approximately around 11 in long is measured ontop of a large ground plane (45 60 in ). A photograph of the deployed (11 in) and stowed (3.4 in) monopole on top of the ground plane is used. The antenna is rolled and unrolled about 10 times, and the reflection coefficient is measured each time with no significant changes, proving that the antenna function is preserved through mechanical cycles. The comparison between the average measured reflection coefficient and the simulated data. Measurement results of the monopole verify the simulation approach and the feasibility of using this composite tapespring structure for antenna design.

## III. PROPOSED SYSTEM

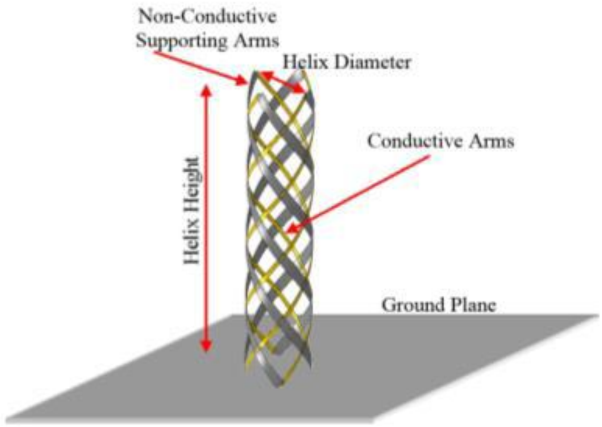


**Fig 4: The Antenna Structure With Conductive Arms Shown In Thin Lines And Non-Conductive Supporting Arms Shown In Thick Lines**

The quadrifilar helix antenna is measured on top of a square ground plane with a side of 1.25$\lambda$ (1.02 m). The antenna's measured reflection coefficient presents good agreement with the simulated one. The QHA operates between 352 MHz and 378 MHz with a center frequency at 365 MHz and 7.12 % Bandwidth. The QHA's measurement setup and the gain pattern of the antenna is highlighted. A peak gain of 8.38 dB is achieved at $f$=365 MHz. The antenna is also circularly polarized with an axial ratio that is below 3 dB at 365 MHz and throughout the whole radiation beamwidth axial ratio across the complete operational bandwidth of the QHA proving that the antenna is circularly polarized across the full frequency span. Structural tests are also executed on the antenna to measure compaction loads and the resulting deformated.

A comparison between both types of helical antennas that are presented in this paper needs to take into consideration all the important characteristics that such antennas exhibit and execute a trade-off analysis between each of them.

Bandwidth: Both antennas are designed to operate in the UHF band of operation; however the QHA exhibits a single frequency operation while the CLSA is more of a wideband antenna due to its logarithmic and frequency independent structure.

**Polarization:** Both antennas are circularly polarized due to their helical nature.

**Radiation Pattern:** The QHA has an omnidirectional pattern however the addition of a ground plane that deploys with the antennas allows its directive behavior away from the CubeSat. On the other hand the CLSA is directive away from the satellite without the need for a deployable ground plane underneath its structure.

**Gain:** The QHA exhibits a higher gain than the CLSA due to its structure composed of four arms. However it is important to note that the CLSA exhibits an almost constant gain value over the entire bandwidth of operation.

**Feeding Mechanism**: Both antennas require an appropriately designed feeding network. QHA requires a quadrature progressive phase shift between its constituent elements while the CLSA requires a balun that provides appropriate impedance matching and power division.

**Deployment and Folding:** The QHA resorts to helical pantographs for deployment while the CLSA resorts to flattening and Z folding patterns. Both antennas exhibit high stiffness and natural frequencies away from the environmental forcing frequencies which makes them highly stable while deployed.

The design characteristics of two potential antenna structures to be deployed from CubeSats are discussed in this paper. Helical antenna types appear to be suitable candidates for such deployment. The design and structure of a quadrifilar helix antenna as well as a conical log spiral antenna are discussed. While both antennas exhibit circular polarization and a high gain, the quadrifilar helix antenna requires a deployable ground plane for radiation redirection. The conical log spiral antenna is a wideband antenna that covers the desired bandwidth while the quadrifilar helix antenna restricts its operation to a single frequency. Both antennas resort to advanced folding mechanism to be able to achieve high packaging ratios during launch. The feeding mechanism of each antenna type is discussed and a comparison is presented between both antenna candidates.

## IV. EXPERIMENTAL RESULTS

The proposed circuit are designed and simulated by using ansys HFSS with airbox .our proposed structure give considerable amount of improvement in gain

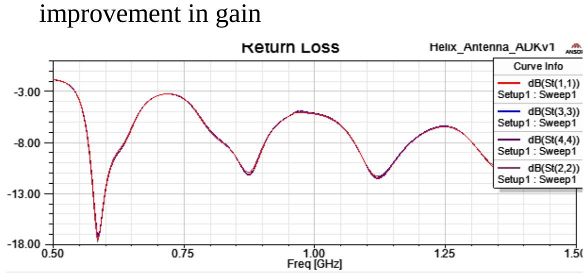


**Fig 5 Return Loss**

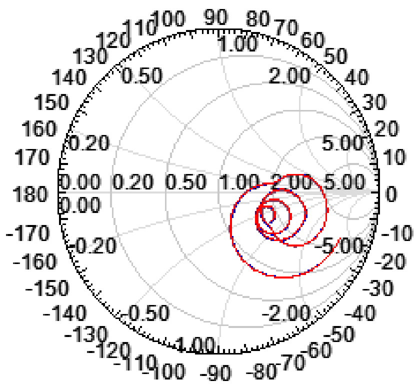

**Fig.6 Gain**

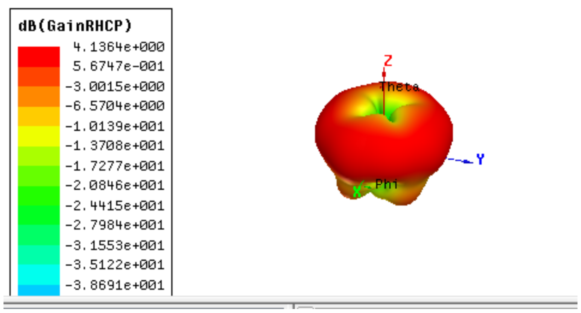


**Fig.7 Impedance**

## V. CONCLUSION

A new conductive composite structure is proposed for CubeSat deployable antennas that is constructed using a brass with an embedded copper alloy conductor. This merging introduces new deployable antenna possibilities. The designs based on such composites are proven to be robust, rigid, and stable to satisfy all the constraints of a CubeSat platform.

## REFERENCES

[1] R. D. Straw, The ARRL Antenna Book. Newington, Conn.: The American Radio League, Inc., 2008.

[2] J. D. Kraus, Antennas for all Applications. McGraw Hill Book Company, 2001.

[3] K. L. Bryan Klofas, Jason Anderson, "A survey of cubesat communication systems," in CubeSat Developers Conference, November 2008.

[4] C. Clark, A. Chin, P. Karuza, D. Rumsey, and D. Hinkley, "Cubesat communications transceiver for increased data throughput," in Aerospace conference, 2009 IEEE, march 2009, pp. 1 –5.

[5] P. Rossoni, "Structural bus and release mechanisms on the st5 satellite summary and status," in Aerospace Conference, 2007 IEEE, march 2007, pp. 1 –14.

[6] A. Safaai-Jazi and J. Cardoso, "Radiation characteristics of a spherical helical antenna," Microwaves, Antennas and Propagation, IEEE Proceedings, vol. 143, no. 1, pp. 7 –12, feb 1996.

[7] [7] H. King and J. Wong, "Characteristics of 1 to 8 wavelength uniform helical antennas," Antennas and Propagation, IEEE Transactions on, vol. 28, no. 2, pp. 291 – 296, mar 1980.