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DEVELOPMENT OF 20dB HELICAL ANTENNA OPERATING IN AXIAL MODE FOR EFFECTIVE COMMUNICATION

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ABSTRACT: Rapid advance in information giving out through communication network brought about information network system, which helps telecommunicating stations whereby any transmission from inaccessible area, can be relayed through antenna to any part of the world. Some stations operate effectively and have wide coverage area but some can hardly be received even within the state not talk about outside the state. One of the problems associated with television transmission is the attenuation of signal with distance and to reduce this effect a very sensitive and high gain antenna have to be installed with receiver to improve signal strength in fringe area where the signal is too weak to give clear reception. Hence, this brought about development of a 20dB Helical antenna to strengthen the transmitted signal at fringe locations without necessarily using electronic amplifier.
KEYWORDS: electromagnetic waves, radiation, gain, helical, frequency, wavelength, directivity, signal, strength, antenna, attenuation

INTRODUCTION

Communication and information dissemination plays a vital role in human life. Speech and music are transmitted directly from their sources to listeners across short distances by means of acoustic wave. Similarly, a picture is transmitted directly by optical waves across short distances. However, to transmit signals for over long distances, wire and radio communication are used and it is a special circuit component called “antenna” which has made the radio communication possible in practice (Collin, 1985). An antenna is a metallic structure used to convert high frequency current to electromagnetic waves, and vice versa. This wave is the energy sustained in space by electricity and magnetism, which propagate according to light laws (Ballanis, 1982). If the antenna is not precisely the right length for the frequency used, the radio waves cannot be emitted or captured efficiently; hence it should neither be too long nor too short (Chatterjeer, 1989).

However, one of the problems attributed to signal transmission is the attenuation of the signal with distance from the radiating source (William, 1987). To reduce this effect there is need to install an antenna of a very high gain and sensitivity with low cost of construction, accessible and obtainable by the common man to give a clear reception.

PROBLEM DEFINITION

Many broadcasting stations operate effectively and they have wide coverage area but it has been observed that T.V signal viewers living in remote areas do not receive faithful signal transmitted into the troposphere from transmitting stations because of the distance and physical conditions. It has been realized that there is need to improve the gain and reduce the noise level of the signal in order to annul the adverse consequence of fading while programme is being relayed to space. To achieve this, a very sensitive and powerful high gain antenna has to be installed with T.V receiver to improve reception at fringe locations.

Many antennas, especially, Yagi antennas are common everywhere both in rural and urban area but these types of antennas are able to achieve their goal only with the aid of electronic amplifier (booster) coupled with them. Hence, there is a need to develop a cost-effective method of improving signal level which will not rely on electronic amplifier. One of the antennas that possess this characteristic is the Helical antenna. Consequently, this brought about design and construction of a 20dB Helical antenna to strengthen received signals. This antenna is applicable at higher frequencies, particularly as a U.H.F and V.H.F transmitting-receiving antenna (Kraus, 1998).

RELEVANCE OF THE STUDY & OBJECTIVE

The purpose and significance of this research work is twofold, namely;

- To effectively couple to space the output of a transmitter or the input of a receiver.
- To improve the electromagnetic wave level at a particular location.

The main focus of the study is to reduce the noise level and improve the gain of the antenna in a fringe area to produce faithfully,

- *The shape of an object (structure)*
- *Relative brightness of the object*
- *The sound*
- *The motion and*
- *The colour of the object.*

DESIGN ANALYSIS - Description of the antenna

The Helical antenna consists of a loosely wound helix backed up by a ground plane, which is simply a screen made of "chicken" wire. This is a broadband VHF and UHF antenna that produces circular polarization characteristics, mainly, for reasons, transmissions to and from the satellite may be received satisfactorily, no matter how they have been rotated in the ionosphere (Jordan, 1968). They are common with the broadcasting station that transmits with frequency modulation. It is frequently used for satellite and probe communication, particularly for radio telemetry (Dunlop and Smith, 1998).

The axial mode in Helical antennas is generated by a coaxial feed, the inner conductor of which is connected to one end of the antenna and the outer conductor is connected to the ground plane.

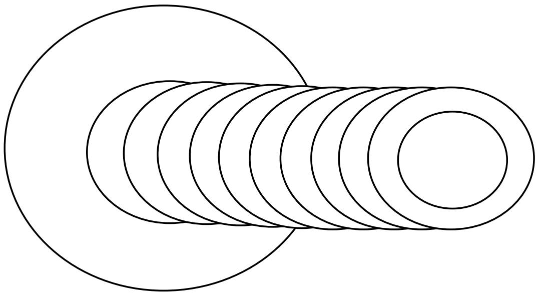


Figure 1. Physical structure of Helical antenna

The symbols used in describing the geometry of the helical antenna are as given below: L = length of one turn of the helix; D_h = diameter of the helix; S = spacing (centre to centre) between any two adjacent turns; N = total number of turns in the helix; a = pitch angle; A = NS (axial length of the helix); d_c = diameter of the helix conductor; D_G = diameter of the ground plane; d_g = distance of the helix proper from the ground plane

Helical antenna design parameters

The typical design parameters of the antenna are given below (Ballanis, 1982).

$$d_c = 0.02\lambda \quad d_g = 0.12\lambda \tag{1)- (2}$$

$$D_h = 0.32\lambda \tag{3}$$

$$c = \prod D = 1.005\lambda \tag{4}$$

$$D_G \geq 0.8\lambda \tag{5}$$

$$\alpha = arc\tan\frac{s}{c} = Pitch\,angle \tag{6}$$

$$S = 0.22\lambda \tag{7}$$

$$R = 140\frac{c}{\lambda}\ Ohms \tag{8}$$

The axial ratio for maximum directivity of the polarization in the axial direction of the helix is given as;

$$AR = \frac{2N + 1}{2N} \tag{9}$$

The performance characteristic of the helix is given as;

$$Gain \cong 15\left(\frac{c}{\lambda}\right)^2 \frac{NS}{\lambda} \tag{10}$$

The half power beam width of the radiation pattern is given as;

$$\beta = \frac{52}{\frac{c}{\lambda}\sqrt{\frac{A}{\lambda}}}\ (deg\ rees) \tag{11}$$

The beam width between the two nulls of the major lobe is given as;

$$\delta = \frac{115}{\frac{c}{\lambda}\sqrt{\frac{A}{\lambda}}}\ (deg\ rees) \tag{12}$$

The antenna was designed and fabricated in Electronics/Telecommunication Laboratory, Electrical/Electronic Engineering Department, Osun State College of Technology, Esa-Oke, Nigeria using low-cost and readily available materials. The configuration of the antennae is shown below.

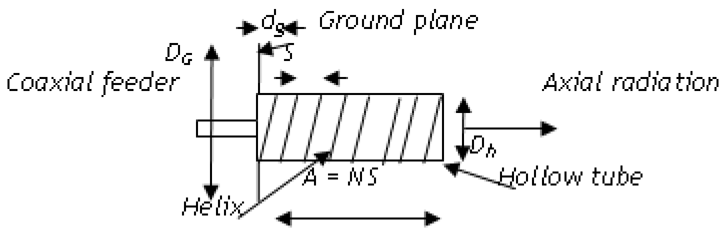


Figure 2. Helical antenna geometry

Aluminum cable is used to construct the loosely wound helix backed up by a ground plane. The choice of this material is base on the necessity to prevent corrosion over the surface, which would result in the deformation of the antenna surface and hence hinder the adequacy of reflection, radiation and loss of signal (Jazonov, 1990). Also, the material was used because of its weight advantage, so that the weight of the antenna would not supersede the weight of the stand and destabilize the erection of the antennae, since it must be mounted upright in an open space and PVC-pipe was used to serve as a helix supporter.

RESULT AND DISCUSSION

The main focus of the design is the field strength in the main beam which should be larger than a critical minimum value frequency. The requirement for this was that the directivity should be large enough over the whole frequency band and that the antenna's input impedance match to the generator should be reasonable over the whole frequency band.

If the impedance of the antenna matches the generator reasonably well enough, then the VSWR will be small. Together, these conditions should lead to sufficiently high field strength at the receiver over the whole frequency band.

Let consider the transmitter of Osun State Broadcasting Corporation (television service) Ile Awiye, Oke-Baale, Osogbo in Nigeria which operate on channel 32 UHF, (578 - 584) MHz as a case study. The design parameters for the helix operating between 578MHz and 584MHz in axial mode are then calculated as follow:

$$Centre\ \ frequency, f = \frac{578 + 584}{2} = 581\ MHz$$

The corresponding wavelength is given as (Siwiak, 1995);

$$\lambda = \frac{v}{f}$$

where, v is the velocity of propagation of electromagnetic wave.
Thus,

$$\lambda = \frac{v}{f} = 0.516m$$

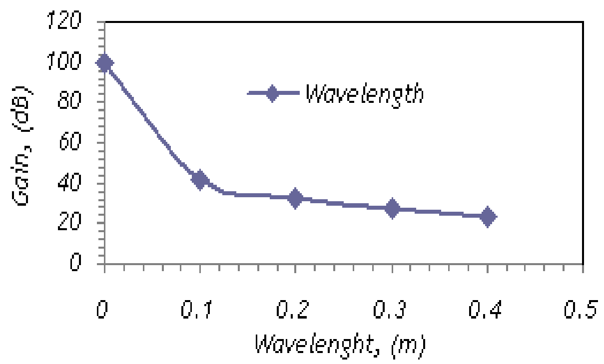
$d_c = 0.01m$, $d_g = 0.062m$, $D_h = 0.165m$, $c = 0.52m$, $D_G \geq 0.413m$, $S = 0.114m$, $a = 12.37^0$
$R = 141.09\ \Omega$, $N = 29.7 \approx 30$, since $G = 100$ (gain), $AR = 1.0166$, $A = 3.42m^2$, $B = 20.08^0$ and $\delta = 44.04^0$.

From design calculated values, the construction of the antenna was realized. The constructed antenna was tested and the results obtained were tabulated as shown in Table 1. The test arrangement was shown in Figure 4 below.

The antenna gain-wavelength characteristic was shown graphically in Figure 3. Although, this antenna was designed and constructed to operate for particular range of frequency, the curve shows that the antenna can be used to operate for another range of frequency outside the above given range, but the gain will be inversely proportional to the wavelength. Thus, the observed limitation of the study is that the frequency of effective reception is limited to about 18% of centre frequency.

Table 1. Wavelength (λ) of the antenna with their corresponding gain (G)

.λ (m)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
G (dB)	100	41.4	32.4	27.1	23.3	20.4	18.1	16.1	14.3	12.8	11.4



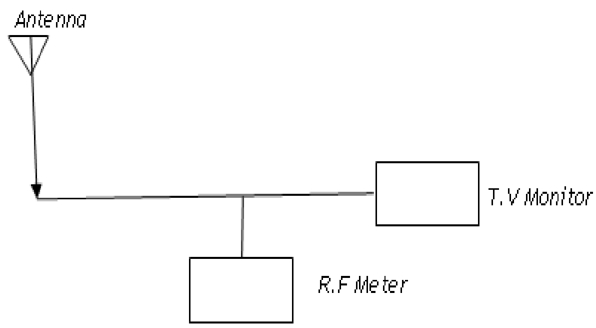


Figure 3. The antenna gain-wavelength characteristic Figure 4. The test arrangement of the antenna

CONCLUSIONS

Since the problem attributed to electromagnetic wave is the attenuation of the signal strength with distance from the radiating source. In order to minimize this effect there is need to install an antenna that would possess the characteristic of high sensitivity and gain. From result obtained, this shows that Helical antenna can perform the task without the use of electronic amplifier. The study has brought about the use of locally sourced materials that can easily be obtained at low cost. Also, the study paves the way for further research work in low-cost antenna for improved signal-to-noise ratio in television signal reception.

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