Helical Antennas with Truncated Spherical Geometry

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(Abstract)

A new variation of the spherical helical antenna made of a wire wound over a hemispherical surface and backed by a conducting ground plane is introduced. A constant spacing is maintained between the turns of winding. The geometry of this antenna is fully described by the number of turns and the radius of hemispherical surface. In addition to the hemispherical geometry, truncated double spherical helices are also examined. Radiation properties of the proposed antennas are studied both theoretically and experimentally. The wire antenna code ESP (electromagnetic surface patch), which is based on the method of moments, is used to obtain simulation results. The results for far-field patterns, gain, axial ratio, bandwidth, and input impedance are presented. Several prototypes of this antenna were constructed and tested using an outdoor antenna range. Far-field patterns were measured over a wide range of frequencies. The measured and calculated radiation patterns are in good agreement.

A unique property of the hemispherical helix is its broad half-power beamwidth. Furthermore, this antenna provides circular polarization and relatively high gain over a narrow frequency range. The results of this research show that, for example, a 4.5-turn hemispherical helix with a radius of 0.02 meter designed for operation around 2.8 GHz provides a half-power beamwidth of about 90 degrees, more than 9 dB gain, and less than 3 dB axial ratio over a 300 MHz bandwidth. The input impedance of the antenna is largely resistive and is about 150 ohms in the above frequency range. Compared with a full spherical helix, the hemispherical helix provides comparable radiation characteristics, but occupies only half the volume. The compact size of this antenna makes it attractive to mobile communication applications.