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An optimization method for tuning a helical beam antenna using Blender-Python and CFDTD

G. Richichi* (1) and G. Junkin (1)
(1) Department of Telecommunications & Systems Eng., Universidad Autónoma de Barcelona, Barcelona, Spain; e-mail: giulio.richichi@uab.cat; gary.junkin@uab.cat

CFDTD is a powerful method in computational electromagnetism which is used to study the solutions of the Maxwell equations in the time domain [1]. It relies on the creation of a 3D model of the radiating structure, which can be performed by using software such as Blender [2]. Blender is a free software that permits the creation of 3D models of an object. These models can be exported in .obj format and then be used in the CFDTD software to carry out time domain EM simulations. The modelling process can be controlled by means of scripts written in Python [3], which permit a considerable reduction in the time needed for design. This means that a model can be easily modified by changing the value of some variables along the script, without the need to repeat every time the whole procedure. This allows us to tune some characteristics of the antenna with a few iterations. In this paper, we present an optimization method for tuning the resonant frequency and impedance of a helical beam antenna using Blender-Python and CFDTD. A helical beam antenna is capable of generating a beam with a helical phase pattern, which can be useful in data transmission via near-field communication [4]. Our antenna consists in a slotted dielectric loaded coaxial resonator, which radiates at the frequency of 10 GHz the circular modes generated by E-plane ring resonators connected to the bottom side via slots [5]. The slot width of the coaxial resonator is useful to control the beam waist, which is an important parameter influencing beam propagation, while the E-plane ring resonators must be fed by two ports electrically phased 90º, whose position depends on the mode we need to generate. This antenna is capable of radiating multiple helical modes between them, which has been a challenge to date [6]. In order to minimize the coupling between the modes, an optimization procedure is developed which adjusts, at every iteration, some parameters of the antenna (physical dimensions, ports impedance) until the difference between the desired value of S-parameters and the simulated ones are lower than a fixed threshold.

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2. Blender Foundation, "Blender is the free and open source 3D creation suite", https://www.blender.org/.

3. Python is a programming language that lets you work quickly and integrate systems more effectively, https://www.python.org/

4. L. Allen, M. W. Beijersbergen, R. J. C. Spreeuw, and J. P. Woerdman, " Orbital angular momentum of light and the transformation of Laguerre-Gaussian laser modes", Phys. Rev. A Vol. 45, Iss. 11, pp. 8185-8189, June 1992.

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