Approximating the Radiation Pattern of an Antenna in Complex Scenarios from Partial Information

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Nyquist criterion gives a lower bound to the number of sampling points where the Far Field (FF) of a radiating structure must be measured in spherical coordinates to be able to express the field with arbitrary accuracy on any direction using spherical harmonics (J. Hansen, *Spherical Near-field Antenna Measurements*, 1998). However, if additional information is available, a smaller number of samples can be used (G. Giordanengo et al., IEEE Trans. on Antennas and Propagation 62:5, 2014).

In this contribution, we consider an antenna placed on a electrically larger structure. We can leverage on knowledge of the FF pattern of the antenna in isolation, its position and spatial occupation, and the geometry of the scattering structure. Calling $\boldsymbol{E}_0(\theta,\phi)$ the *known* field radiated by the antenna in isolation and $\boldsymbol{E}(\theta,\phi)$ the *target* reference field radiated by the antenna placed on the structure, we look for an approximation in the form $\boldsymbol{E}(\theta,\phi) \approx \tilde{\boldsymbol{E}}(\theta,\phi) = \boldsymbol{E}_0(\theta,\phi) + \boldsymbol{E}_s(\theta,\phi)$. We expand the *unknown* part $\boldsymbol{E}_s$ in a linear combination of basis functions obtained considering elementary sources on a surface enclosing the antenna. To determine the coefficients of the expansion of $\boldsymbol{E}_s$, we enforce matching of the target field values $\boldsymbol{E}(\theta,\phi)$ with $\tilde{\boldsymbol{E}}(\theta,\phi)$ on a reduced set of points. We then evaluate the linear combination on all the requested observation points. The whole procedure amounts to an approximation of the field $\boldsymbol{E}$ from a reduced set of samples.

In a a controlled synthetic test, where the reference field $\boldsymbol{E}$ is obtained with high accuracy numerical simulations, we study the relative error on the whole set of points as a function of the number of matching points. We obtain a negligible error with e donwsampling factor of more than ten with respect to standard Nyquist criterion (Figure 1).

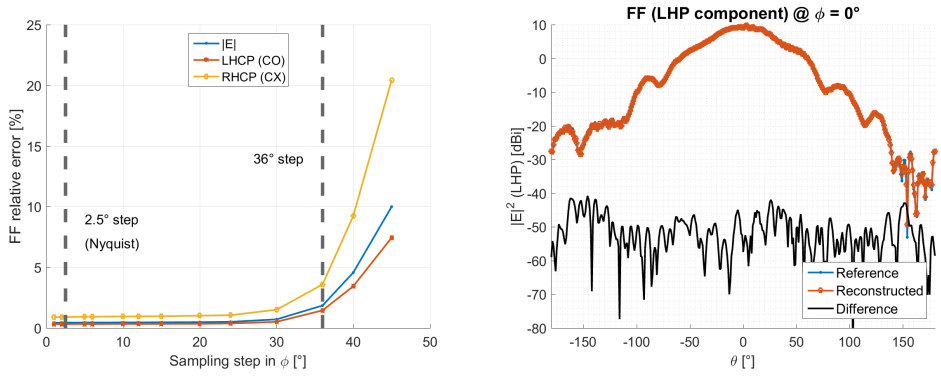

Figure 1: Relative error on the FF for different downsampling on the ϕ coordinate. Copolar FF on the cut $\phi = 0°$ with ϕ sampling of 36°.