Characterizing the Coherent Reflected Power Dependence on Rough Surface Height at Low Signal Levels

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Abstract

Traditionally, the Global Navigation Satellite System reflectometry (GNSS-R) community has used the Kirchhoff approximation to model how the coherent reflected power falls off as a function of the RMS height of the rough surface profile considered. While this approximation has been valid for most GNSS-R applications to date, the community has recently raised the question of the model's validity when the normalized coherent reflected power is very low (≤ -20 dB) due to increased interests in measuring the coherent reflected power in situations where the incoherent reflected power is dominant. To investigate the trend of the normalized coherent reflected power below -20 dB, Monte Carlo simulations were performed by randomly generating Gaussian rough PEC surfaces with various RMS heights and averaging over multiple realizations at each RMS height to obtain a reflected power whose incoherent component has been averaged out, leaving only the coherent reflected power behind. The analyses performed consider the statistics of the Rician random variable obtained when coherent specular scattering from a rough surface is measured. Because both coherent and incoherent components are present, the ability to estimate the coherent signal level depends strongly on the ratio of the coherent to incoherent powers.

The range of RMS heights considered in the simulation is found to be limited by the rapid increase in the number of realizations needed to average out the incoherent reflected power at larger RMS surface heights, as well as the desire to consider terrain profiles that are commonly experienced in GNSS-R applications. Results from the simulation will be shown in the presentation in order to assess the applicability of the standard physical optics assumption for the decay of the coherent reflected power with roughness. The implications of these results for GNSS-R sensing will also be discussed.