The Design of Two-dimensional Randomly Rough Surfaces with Specified Scattering Properties: Non-normal Incidence

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In a recent paper [1] a method was proposed for designing a two-dimensional randomly rough surface on which the Dirichlet boundary condition is satisfied that, when illuminated at normal incidence by a scalar plane wave, produces a scattered field whose mean differential reflection coefficient has a specified dependence on the scattering angles. The method was based on the geometrical optics limit of the Kirchhoff approximation. The mean plane of the surface, the x_1x_2 plane, was tessellated by equilateral triangles. For x_1 and x_2 within a given triangle the surface profile function $\zeta(x_1x_2)$ was assumed to be a linear function of x_1 and x_2 of the form $b^{(0)} + a^{(1)}x_1 + a^{(2)}x_2$. The pair of slopes $a^{(1)}$ and $a^{(2)}$ for a given triangle were assumed to be random deviates that were independent of the pair of slopes for any other triangle, and all pairs of $a^{(1)}$ and $a^{(2)}$ had the same joint probability density function. The amplitude $b^{(0)}$ was determined by making the surface continuous. The mean differential reflection coefficient was found to be given in terms of this joint probability density function. This relation could be inverted to yield the joint probability density function in terms of the mean differential reflection coefficient that the surface was intended to produce. From the joint probability density function for $a^{(1)}$ and $a^{(2)}$ the marginal probability density functions were obtained, as well as the conditional probability for $a^{(2)}$ given $a^{(1)}$, and vice versa. The rejection method [2] was then used with these marginal and conditional probability density functions to construct an ensemble of realizations of the random surface. In the present work we extend the approach proposed in [1] to the case of non-normal incidence, and illustrate it by applying it to the design of a surface that scatters a plane wave in such a way as to produce a mean scattered intensity that is constant within a rectangular region of scattering angles, and produces no scattering outside this region. It is validated by the results of numerical simulation calculations.

REFERENCES

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