Scattering from a Distribution of Rough Plates

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Modeling how waves scatter from a distribution of rough plates poses many applications. Certain systems may be easy to approximate with planar geometry, but use of numerical field solvers to determine the radiated fields could take a large amount of time for nontrivial structures. One possible use of this model includes determining an arrangement of reflective plates to form a radiation characteristic that is uniform along one spatial dimension at optical frequencies. The model can also be used in an urban environment to calculate unwanted ground-to-air reflections caused by planar surroundings such as vehicles.

The Kirchhoff approximation for electromagnetic wave scattering off of a finite-sized rectangular plate is well understood. This presentation will describe an iteration on the existing formulation. Specifically, this will consider the case of multiple rough, finite-sized rectangular plates. Software is used to determine the scattering of waves off of a distribution of rough plates, of arbitrary position and orientation between a transmitter and receiver.

Given a transmitter and receiver with arbitrary location and radiation pattern, the program first considers each plate individually. The electric field at the receiver is calculated based on the parameters of an individual plate and its location. The field can be calculated in either vertical or horizontal polarization. It is based on a model of a ray propagating from the transmitter to the plate in free space, reflecting off of the plate, and then propagating through free space to the receiver. Both coherent and incoherent scattered fields are considered. The program iterates through each plate, repeating this process. Once the field due to each plate is determined, the fields are all summed together. By the superposition principle, this determines the resultant field at the receiver from the entire distribution of plates. The receiver position can then be swept over a certain range with respect to the transmitter to determine the effective radiation pattern of the plate distribution.

The limitations on the formulae come in from the simplifications used in the calculations. The transmitter and receiver must be in the far field from the plates. There is additionally no assumed transmission through the plates, and the plates also must be spaced sufficiently far from each other. The equations only consider one plate at a time, meaning that near field interference between neighboring plates is not considered.