Optical imaging through discrete random media based on point source radiative transfer equation: shower curtain effect

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Imaging through discrete random media is an important area of research with applications in biomedical diagnoses and atmospheric imaging. It is well known that discrete random media, such as biological tissues and fog and clouds in the air, degrade the quality of images. The main reason is the effect from particle scattering, which causes poor resolution and contrast. Therefore, there is considerable interest in modeling the random media and reducing the effect of scattering from particles.

For the optical imaging problem, radiative transfer theory is predominantly applied because of its simplicity relative to the more complex field scattering solution based on Maxwell's equations. The radiative transfer equation is based on the addition of power; thus, it provides only the intensity information. The equation is an integro-differential equation which cannot be solved analytically. However, for the plane-parallel problem, the equation can be reduced to a form that can be computed numerically.

The plane-parallel problem has been used extensively because it can be applied to many real-world applications. In our previous work (A. Ishimaru, S. Jaruwatanadilok, and Y. Kuga, *Applied Optics*, **40** (30), 5495-5502, 2001), we derived the modified pulse vector radiative transfer equation in the plane-parallel problem with plane wave incidence. Here, we extend our previous work using the same geometry, but consider a point source. The main contribution of this approach is that it provides the dependence on the location of the source, the object, and the random medium, which makes the equation a closer approximation to real imaging scenarios. We explain the assumptions and approximations of this method. We also make numerical simulations of the image through discrete random medium using this point source approximation method and compare the results with those of plane wave incidence. We can also apply the point-source approximation to verify the phenomenon called the *shower curtain effect*, which states that not only the properties but also the *location* of the random medium relative to location of the source and observation affects the quality of the image.