On calculation of the electromagnetic field in the vicinity of a transmitter located near the dielectric half-space.

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For some remote sensing applications such as soil parameters retrieval, or medical applications, calculation of the electromagnetic field in the vicinity of a transmitter located near the dielectric body is of interest. The case of a dielectric half-space with a planar boundary is a classical problem. Although exact integral representation of the solution exists, it is sufficiently complex, and numerical result cannot be easily obtained. Before powerful computers came along, a lot of attention was paid to analytical development of various asymptotical expressions for the field propagating near such a boundary. Nowadays integral representations of the solution of this problem allow direct numerical evaluation for not too large distances.

A simple integral representation of the exact solution of the problem which is somewhat different from usually used is considered. This form of the solution is particularly easy to implement in Matlab due to existence of a fast standard Matlab function for calculation of the zero-th order Bessel function for a set of real arguments. We considered a few practical examples, and it was found that the geometrical optics (GO) limit is significantly different from the exact solution in the range of parameters where one might expect the GO limit to be already reached.

For distances which are very large with respect to the wavelength, a direct numerical integration may become problematic. However, in the general case a corresponding expression can be calculated by integration over the steepest descent path for which an explicit analytical expression is known.

Also, the exact field representation allows us a simple analytical asymptotic analysis. In our case, the structure of cuts on the complex plane is simpler than that, for example, in the well-known Sommerfeld representation of the solution. The ranges of parameters when contributions from the cuts (ground or Norton wave) and from the pole of the reflection coefficient (the Zenneck wave, also known in optics as a surface plasmon-polariton) can be easily obtained. It was demonstrated that the Zenneck wave can be exited and measured only in the case when both the transmitter and the receiver are located at distances less than a wavelength from the interface.