Sensitivity Analysis of the Full Wave Solution of a Near-Perfect Lens with $n = -1$

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Smith et al., in their 2003 paper [1], consider the resolution achievable by a single evanescent mode in the case of a nearly perfect lens for which $\epsilon = -1$ but for which $\mu = -1 + \delta_\mu$, and note that there is a deviation from perfect resolution in the case of such material parameters.

We generalise this result by presenting the full wave solution for a dipole source above a slab of left-handed medium (LHM) of refractive index $n = -1$, but with ϵ and μ differing from those ideal values that create the perfect lens through taking

$$\epsilon = -\frac{1}{1+\delta}, \tag{1}$$

$$\mu = -(1+\delta), \tag{2}$$

where δ is real, as in the 2004 paper by Lu et al [2]. It should be noted that depite their deviations from the ideal case, the permittivity and permeability of the slab remain real and so any modifications in resolution are not due to loss effects within the lens. Solutions for the form of the fields throughout all space are obtained using the method of Hertz potentials. The imperfection modelled by the presence of a non-zero value of δ creates a single resonance, rather than the infinity of resonances that is the defining characteristic of the ideal LHM lens, with the effect that the perfect lensing properties are compromised (see in addition Chew [3]).

Using an appropriately defined resolution criterion, we examine the sensitivity of the lens as a function of the material imperfection δ.

REFERENCES

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