Electromagnetic Imaging of Small Scatterers Using MUSIC

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The multiple signal classification (MUSIC) method has been successfully applied to determine the location of point-likes scatterers in acoustic imaging. In electromagnetic imaging, most research work on MUSIC considers 2-dimensional case under the TM incidence. Recently, the application of MUSIC method to electromagnetic imaging is extended to the determination of a collection of small 3-dimensional scatterers. For a small scatterer whose permittivity and permeability are different from those of the background medium, there are usually six (three electric and three magnetic) independent dipoles induced, and the Green's function for each dipole source could be used as the test function in the MUSIC method. However, there are less than three electric or magnetic independent dipoles in the following cases.

1. The special configuration of the transmitting/receiving antennas. For example, when the antennas that form a linear antenna array are oriented in the array direction, only two independent electric dipoles and one magnetic dipole are induced.
2. The special shape of the scatterers. When the scatterers are needle like or disk like, both the electric and the magnetic independent dipoles are less than three.
3. The special composition of the scatterers. For example, for the case of scatterers composed of uniaxial or biaxial materials, when the permittivity or permeability in one of the principal axes is equal to that of the background medium, the electric or the magnetic independent dipoles are less than three.

This paper presents a MUSIC model that deals with the aforementioned degenerate cases. After the positions of the scatterers are determined, the entries of the polarization tensors are obtained by solving a linear equation system.

In conclusion, the paper presents a non-iterative method to solve the nonlinear inverse problem of estimating the positions and the polarization tensors of small scatterers. The proposed method is able of dealing with the degenerate cases and accounts for the multiple scattering between small scatterers.