Simultaneous reconstruction of an obstacle and its Generalized Impedance Boundary Condition

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We consider the inverse obstacle scattering problem of determining both the shape and the equivalent impedance from far field measurements at a fixed frequency. In this work, the surface impedance is represented by a second order surface differential operator (refer to as generalized impedance boundary condition) as opposed to a scalar function. The generalized impedance boundary condition can be seen as a more accurate model for effective impedances and is widely used in the scattering problem for thin coatings. Our approach is based on a least square optimization technique. A major part of our analysis is to characterize the derivative of the cost function with respect to the boundary and this complex surface impedance configuration. In particular, we provide an extension of the notion of shape derivative to the case where the involved impedance parameters do not need to be surface traces of given functions, which leads (in general) to a non-vanishing tangential boundary perturbation. We illustrate the efficiency of considering this type of derivative by several 2D numerical experiments based on a (classical) steepest descent method. The feasibility of retrieving both the shape and the impedance parameters is also discussed in our numerical experiments and we show that these tools are useful to retrieve a perfect conductor coated by a thin layer of dielectric material.