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Detection of Heterogeneous Small Inclusions by a Multi-Step MUSIC Method

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In this contribution the problem of detecting and localizing scatterers with small (in terms of wavelength) cross sections by collecting their scattered field is addressed. The problem is dealt with for a two-dimensional and scalar configuration where the background is given as a two-layered cylindrical medium. More in detail, while scattered field data are taken in the outermost layer, inclusions are embedded within the inner layer. Moreover, the case of heterogeneous inclusions (i.e., having different scattering coefficients) is addressed.

As a pertinent applicative context we identify the problem of diagnose concrete pillars in order to detect and locate rebars, ducts and other small in-homogeneities that can populate the interior of the pillar.

The nature of inclusions influences the scattering coefficients. For example, the field scattered by rebars is stronger than the one due to ducts. Accordingly, it is expected that the more weakly scattering inclusions can be difficult to be detected as their scattered fields tend to be overwhelmed by those of strong scatterers.

In order to circumvent this problem, in this contribution a multi-step MUltiple SIgnal Classification (MUSIC) detection algorithm is adopted [1]. In particular, the first stage aims at detecting rebars. Once rebars have been detected, their positions are exploited to update the Green's function and to subtract the scattered field due to their presence. The procedure is repeated until all the inclusions are detected.

The analysis is conducted by numerical experiments for a multi-view/multi-static single-frequency configuration and the synthetic data are generated by a FDTD forward solver.

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[1] R. Solimene, A. Dell'Aversano and G. Leone, "MUSIC algorithms for rebar detection," J. of Geophysics and Engineering, vol. 10, pp. 1-8, 2013