# Fast Source Imaging Using A Multilevel Non-Uniform Grid Algorithm in Oblate Spheroidal Coordinates

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The Rayleigh-Sommerfeld (RS) back-propagation method applied to a single component of the measured electric field provides a good approximation for the field back-propagated from the measurement plane toward the source. The comparison between the field distribution reconstructed from the measurements and the desired one can be used for the localization of source anomalies. Since the measurement and, consequently, the integration involved in the RS back-propagation, are performed over a finite planar region, the practical implementation of this method is limited by truncation errors originating in a finite size of the measurement domain, which makes the method more suitable for the metrology of directional arrays or large reflector antennas. The usual practice of field back-propagation utilizes the plane wave spectrum (PWS) decomposition. Powered by the fast Fourier transform (FFT) algorithm, the PWS achieves a high computational efficiency, however this technique is limited to planar reconstruction surface and identical sampling steps in both input and output domains. On the other hand, the direct numerical calculation of the RS integral overcomes these limitations at the expense of a high computational complexity, i.e. proportional to the 4th power of the electrical size of the problem. In order to accelerate the RS integration, we propose to use a modified version of the multilevel nonuniform grid algorithm (MLNG), that achieves a high computational efficiency similar to that of the FFT.

The efficacy of the multilevel approach has been recently demonstrated in the case of physical optics analysis of reflector antennas (C. Letrou and A. Boag, IEEE Trans. Ant. Prop., 60/2, 1182-1186, 2012). A full 3D frequency domain MLNG scheme was introduced for fast acoustic field evaluation (Y. Brick and A. Boag, IEEE Trans. Ultrason., Ferroelectr., Freq. Control, 57/1, 262-273, 2010), where it was used for the acceleration of the iterative boundary element method (BEM) solution for the acoustic scattering from rigid targets. The MLNG algorithm is based on field smoothing by phase and amplitude compensation, which allows for sampling of the fields radiated by finite-size source distributions over coarse nonuniform grids. The specific algorithm described in previous research uses nonuniform spherical grids, while in this work it is proposed to utilize oblate spheroidal grids. This kind of grids is found to be more effective in terms of the number of sampling points that are required for correct reconstruction of the fields produced by quasi-planar sources. The method is demonstrated on the example of a parabolic reflector with a surface distortion. A good agreement between the results of the direct RS integration and the proposed method is demonstrated.