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TIME DOMAIN IMAGE RECONSTRUCTION FOR A BURIED 2D HOMOGENEOUS DIELECTRIC CYLINDER USING NU-SSGA

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This article presents an image reconstruction approach for a buried homogeneous cylinder with arbitrary cross-section in half space. The computational method combines the finite difference time domain (FDTD) method and non-uniform steady state genetic algorithm (NU-SSGA) to determine the shape and location of the subsurface scatterer with arbitrary shape. The FDTD-subgirdding technique is implemented for modeling the shape of the cylinder more closely. The inverse problem is reformulated into an optimization problem and the global searching scheme NU-SSGA with closed cubic-spline is then employed to search the parameter space. A set of representative numerical results is presented for demonstrating that the proposed approach is able to efficiently reconstruct the electromagnetic properties of homogeneous dielectric scatterer even when the initial guess is far from the exact one. In addition, the effects of Gaussian noises on imaging reconstruction are also investigated.

Keywords: FDTD, FDTD-subgridding, microwave imaging, NU-SSGA, time domain inverse scattering

1. INTRODUCTION

Inverse scattering comprises of wide spectrum of applications, such as nondestructive problem, medical imaging, geophysical prospecting, where the scattering object with unknown electromagnetic properties are reconstructed by scattered field excited by known set of sources. The most important mathematical characteristic of inverse problems is their ill-posedness [1]. In general, the ill-posed problem can be treated by regularization schemes or transformed into a better conditioned problem [2].

Alternatively, the fact that the inverse problem is nonlinear is due to the dependence of scattering fields upon the electromagnetic properties of scatterer and total field in the scatterer domain simultaneously. The nonlinearity of the problem is treated and resolved by using iterative optimization techniques. As a result, many inverse problems are reformulated into

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