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利用探地雷达频谱反演层状介质几何与电性参数

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An inversion method for geometric and electric parameters of layered media using spectrum of GPR signal

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摘要

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摘要

通过对地下层状介质探地雷达(GPR)回波广义反射系数的奇偶分解,建立了联系GPR反射系数序列频谱与介质几何参数、电性参数的代价函数,这些介质参数包括地下反射面的深度、层厚度以及各层的介电常数和电导率,从而提出了一种由GPR频谱同时估算地下介质多参数的全局优化反演方法.为了对多参数全局优化算法给出一个合理的参数初值,研究了不同参数对反射系数序列频谱属性的影响规律,提出了利用不同频谱属性分别估算不同参数的分步反演方法.以分步反演方法得到的结果作为多参数全局优化反演的初值,可以极大地提高反演计算的效率和反演结果的可靠性.用理论模型合成数据和GPR公路检测数据对本文方法进行了测试,结果表明本文方法效果良好,具有较高的分辨率,能较好的给出厚度小于调谐厚度的薄层的深度、厚度和介电常数等参数.

关键词 层状介质, 探地雷达, 频谱反演, 广义反射系数

Abstract:

The generalized reflection coefficients of underground layered media for Ground Penetrating Radar (GPR) wave are defined and a pair of the coefficient of three-layer media is decomposed into the even component and the odd one. A cost function is established to connect the spectrum of reflection coefficient sequence with the layer's parameters, which include position of reflection interfaces, layers' thickness, dielectric permittivity and electric conductivity. Then a global optimal inversion method is proposed for multiple parameters of underground layered media from GPR signal spectrum. Moreover, through the research on the effects of different parameter on the spectrum of reflection coefficient sequence, a method for estimation of different parameter from different spectral attributes is proposed, namely staged inversion method. The result of the staged inversion was used as the starting value for the global inversion, the efficiency and accuracy of which were then improved greatly. The methods in this paper were tested using synthetic and observed data, and good results of layer thickness, interface position and electric properties were obtained, even when thickness of the layer is less than tuning thickness.

Keywords Layered media, Ground Penetrating Radar (GPR), Spectral inversion, Generalized reflection coefficients

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