Explicit Discretization Schemes for Linear Sampling and Factorization Methods

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Abstract— Qualitative inverse scattering consists of various inverse scattering techniques, which aim to recover only the shape of the target rather than the frequency dependent dielectric parameters of the scatterers [1]. These methods have certain advantages over quantitative approaches. Simplicity of implementation and requirement of less computational resources are just two examples of these advantages. Contradictory to this circumstance, such methods are not widely used in engineering applications like subsurface sensing [2, 3], medical imaging [4] and etc.. In particular, finding a mathematical treatment for the derivation of the explicit discretization schemes of such methods is a problematic issue, especially in the near field region [3, 5]. In this context, this work presents a mathematical derivation of the explicit discretization schemes for two famous qualitative inverse scattering methods, which are the linear sampling method (LSM) and the factorization method (FM), for certain near field measurement scenarios. Explicitly, we mathematically derive the discretizations of the well-known "near-field equations" for three different case: measurements taken on a planar surface, measurements taken on a cylindrical surface, measurements taken on a spherical surface. Apart from giving the discretization of the near-field equations for different measurement configurations, we also mention how the discretized equations related with the physical interpretations of LSM [6, 7]. It is important to note that after understanding the mathematical and physical principles which motivate the LSM and the FM, it is straightforward to extend this analysis to another measurement configurations. Lastly, we also give several experimental reconstructions, which are obtained from Fresnel data [8, 9], to prove the accuracy the derived discretization schemes.

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