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Automated Scaling Region of Interest with Iterative Edge Preserving in Forward-Backward Time-Stepping

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Abstract—A one-shot rescaling process, namely Automated Scaling Region of Interest (AS-ROI), is combined with an inversion technique of Forward-Backward Time-Stepping (FBTS). The purpose is to alleviate the ill-posedness and nonlinearity of inverse problem by reducing the size of the unknown problem. The inversion solution is carried out to reconstruct tumour as an unknown object in coarse investigation domain of lung area which is then rescaled down corresponding to object location and size. In this paper, edge preserving methods consisting of edge preserving regularization and anisotropic diffusion are imposed alternately on the solution and reconstructed profiles to improve the current method of AS-ROI. Results on the reconstructed lungs and tumours give significant insight of the proposed work. Accuracy level for the reconstructed profiles are significantly improved in spite that spatial resolution is retained as the original setting of FBTS.

1. INTRODUCTION

Inverse scattering to solve unknown problems can be unravelled with deterministic [1–3] or stochastic [4–6] inversion solutions. The solution can be formulated either in frequency or time-domain. Findings from several research works in frequency domain of inversion technique with monochromatic source have shown quite satisfying outcomes [7, 8]. The approach has been proven less complex and faster in computation [7]. It also eliminates the needs to compute wave path which is ill-posed to solve [9]. Main limitation of frequency domain implementation is inadequacies of data that can be acquired. In [10], the number of transmitters utilized was up to 128 nodes for single and multi-frequency cases to acquire more data, in which parallel solution was proposed to compensate the computational burden. Apart from that, the implementation in frequency domain approach would be complicated in effort to overcome diffraction limit by reducing the size of wavelength or using high frequency [11].

Multi-frequency technique is commonly proposed to acquire more information on sought object to be characterized as discussed in [12]. Therefore, formulation of inversion solution in time-domain is preferred due to diversity in frequencies that can be exploited. However, common drawback of time inversion technique is the expense of computational despite its potential benefits in image reconstruction. FBTS is a deterministic inversion technique which is implemented in time domain. By exploiting broad range of frequencies to acquire fields scattered by the object in many iterations, the implementation is surely expensive in computation. This problem motivates researchers to improve the conventional method into an effective solution.

Iterative multi-scaling approach (IMSA) is widely applied to increase the precision details of reconstructed images [13, 14]. Segmentation concept in IMSA [1, 15, 16] to extract object location was adapted into AS-ROI method to define new and fine reconstruction region. Innovative aspect of this research work lies in the number of steps required to extract the object's area. In contrast to IMSA,

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