Poster I-30

Blind Estimation of Kinetic Parameters and Input Function for Tumor Vascularity Imaging With DCE-MRI

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Dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) is a noninvasive functional imaging technique capable of assessing tumor microvasculature clinically. In order to determine the kinetic parameters characterizing the tumor vascular activities, the compartmental model analysis is usually performed. The major limitations associated with the conventional region-of-interest (ROI) based methods include the requirement of invasive acquisition of the input function and the labor-intensive identification of the ROIs. In this paper, we propose a novel blind system identification approach for quantitative imaging of tumor vascularity by simultaneously estimating the input function as well as the spatial and temporal characteristics about the underlying tumor microvasculature. The new approach is based on a more general statistical model on the pixel domain. By taking advantages of the specific signal structure involved in our problem, we employ a subspace based algorithm to obtain an initial estimate of parameters. Then, an iterative maximum likelihood technique is developed to refine the estimation results, where the parameters are divided into sub-sets and minimization with respect to the parameters of each sub-set is performed iteratively until the algorithm is converged. From the Monte Carlo simulations, the performance of the proposed scheme is examined extensively under several quantitative measures. The results on both the simulated and real DCE-MRI data sets show a good performance in determining the time activity curves and the underlying factor images when applying the proposed algorithm. Overall, the simulations show that the proposed scheme provides a comparable performance to that of a performance bound in our estimation problem. Furthermore, we study the real data sets of breast tumors. One result on breast tumors of DCE-MRI is shown in Fig. 1, where spatial heterogeneity in structure is clearly revealed and matches the clinical belief. The proposed scheme is promising as a noninvasive imaging analysis for tumor angiogenesis.

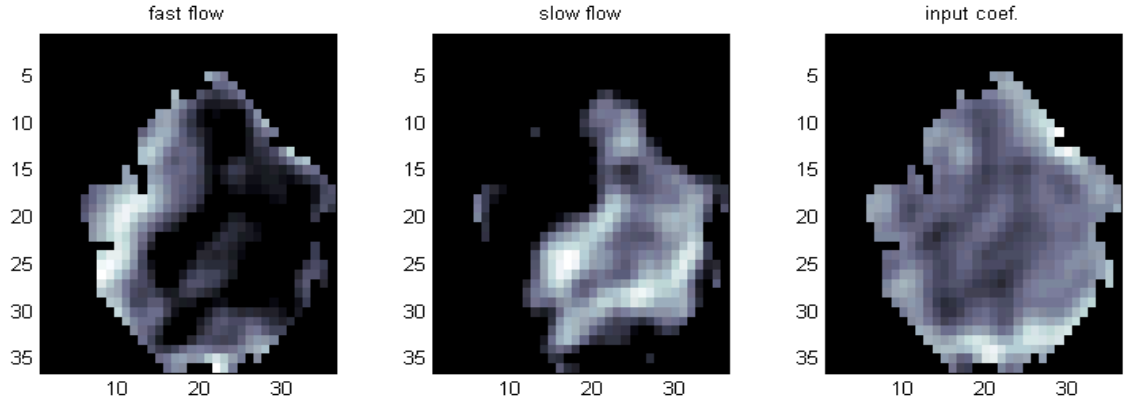

Figure 1: The estimated factor images in the breast tumor. It is obvious that the boundary region is dominated by the fast flow, while the inside region is dominated by the slow flow. Meanwhile, the input signal component is observed everywhere in some sense, with stronger energy around edges.

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