

基于全图自相似的新非局部均值 MRI 去噪算法

Abstract

Magnetic resonance imaging (MRI) is a non-invasive medical imaging technique that provides high-resolution 3D images and valuable insights into human tissue conditions. Even at present, the refinement of denoising methods for MRI remains a crucial concern for improving the quality of the images. This study aims to improve the prefiltered rotationally invariant non-local principal component analysis (PRI-NL-PCA) algorithm. We relaxed the original restrictions using particle swarm optimization to determine optimal parameters for the PCA part of the original algorithm. In addition, we adjusted the prefiltered rotationally invariant nonlocal mean (PRI-NLM) part by traversing the signal intensities of voxels instead of their spatial positions to reduce duplicate calculations and expand the search volume to the whole image when estimating voxels' signal intensities. The new method demonstrated superior denoising performance compared to the original approach. Moreover, in most cases, the new algorithm ran faster. Furthermore, our proposed method can also be applied to process Gaussian noise in natural images and has the potential to enhance other NLM-based denoising algorithms.

Keywords

MRI; Denoising; Non-local mean; PRI-NL-PCA; PNLM-PCA; Self-similarity

摘要

磁共振成像（MRI）是一种非侵入性的医学成像技术，能够提供高分辨率的 3D 图像，并为人体组织状况提供有价值的洞察。即使在当前，改进 MRI 去噪方法仍然是提升图像质量的一个关键问题。本研究旨在改进预滤波旋转不变非局部主成分分析（PRI-NL-PCA）算法。我们通过粒子群优化放松了原始限制，以确定原算法中 PCA 部分的最优参数。此外，我们通过遍历体素的信号强度而非其空间位置，调整了预滤波旋转不变非局部均值（PRI-NLM）部分，从而减少了重复计算，并在估计体素信号强度时将搜索范围扩展到整个图像。新方法相比原始方法表现出更优的去噪性能。此外，在大多数情况下，新算法运行速度更快。此外，我们提出的方法还可用于处理自然图像中的高斯噪声，并有潜力增强其他基于 NLM 的去噪算法。

关键词

磁共振成像；去噪；非局部均值；主成分分析；自相似

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Session Classification: 核技术与应用、医学物理与工程

Track Classification: 03 口头报告: 核技术与应用、医学物理与工程