Application of Deep Learning-Based Methods in Magnetic Resonance Elastography (MRE)

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Background: Magnetic Resonance Elastography (MRE) is an emerging imaging technique that allows for non-invasive quantitative assessment of various biophysical parameters in human tissue, such as viscosity and stiffness. Despite its potential, MRE, in comparison to conventional imaging methods like ultrasound or magnetic resonance imaging, faces several challenges, including manual evaluation through the drawing of regions of interest. Manual assessment of MRE data is susceptible to low intra- and inter-rater reliability and is time-consuming. Moreover, MRE exams can be affected by patient motion due to breathing or shifting. In this study, we explore the utility of deep learning-based methods for MRE data analysis and enhancement.

Methods: Deep learning methods have gained significant attention in recent years for biomedical image analysis. We conducted an extensive literature review to identify prior work on the application of deep learning in MRE. We tested similar approaches on MRE data collected in our laboratory, utilizing deep learning for tasks such as image enhancement and exam interpretation.

Results: Aldoj et al. employed deep learning to automate the quantification of biomechanical tissue parameters in prostate MRE, achieving performance comparable to human readers and enabling automated quantification of tissue viscoelasticity [1]. Pollack et al. developed a deep learning-based model capable of predicting liver stiffness using conventional MRI images, which may enhance result reliability assurance [2]. Shan et al. explored the feasibility of accelerating MRE using deep learning and demonstrated its potential for rapid MRE acquisition [3]. Our team also developed and tested deep learning-based algorithms for automated image segmentation and patient motion reduction. Our algorithms automatically delineate the region of interest (with a dice score of approximately 0.7) and generate motion-free images with an approximately 30% relative error compared to ground truth images.

Conclusions: Deep learning proves to be a robust tool for biomedical image analysis, encompassing tasks like region of interest segmentation, image assessment, and quality enhancement. However, although deep learning shows promise in various aspects of MRE, further development is necessary for its full integration into clinical practice.

References:

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