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Application of Compressed Sensing and Different Sampling Trajectories for Data Reduction of Small Animal Magnetic Resonance Image

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Abstract : Magnetic Resonance Imaging (MRI) is a vital imaging technique used in both clinical and pre-clinical areas to obtain detailed anatomical and functional information. However, MRI scans can be expensive, time-consuming, and often require the use of anesthetics to keep animals still during the imaging process. Anesthetics are commonly administered to animals undergoing MRI scans to ensure they remain still during the imaging process. However, prolonged or repeated exposure to anesthetics can have adverse effects on animals, including physiological alterations and potential toxicity. Minimizing the duration and frequency of anesthesia is, therefore, crucial for the well-being of research animals. In recent years, various sampling trajectories have been investigated to reduce the number of MRI measurements leading to shorter scanning time and minimizing the duration of animal exposure to the effects of anesthetics. Compressed sensing (CS) and sampling trajectories, such as cartesian, spiral, and radial, have emerged as powerful tools to reduce MRI data while preserving diagnostic quality. This work aims to apply CS and cartesian, spiral, and radial sampling trajectories for the reconstruction of MRI of the abdomen of mice sub-sampled at levels below that defined by the Nyquist theorem. The methodology of this work consists of using a fully sampled reference MRI of a female model C57B1/6 mouse acquired experimentally in a 4.7 Tesla MRI scanner for small animals using Spin Echo pulse sequences. The image is down-sampled by cartesian, radial, and spiral sampling paths and then reconstructed by CS. The quality of the reconstructed images is objectively assessed by three quality assessment techniques RMSE (Root mean square error), PSNR (Peak to Signal Noise Ratio), and SSIM (Structural similarity index measure). The utilization of optimized sampling trajectories and CS technique has demonstrated the potential for a significant reduction of up to 70% of image data acquisition. This result translates into shorter scan times, minimizing the duration and frequency of anesthesia administration and reducing the potential risks associated with it.

Keywords : compressed sensing, magnetic resonance, sampling trajectories, small animals
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