Undersampled MRI reconstruction

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Abstract

Magnetic Resonance Imaging (MRI) examination times can vary from fifteen minutes to one hour, which is inconvenient for both the doctor and the patient. Additionally, human motion during the scan can significantly decrease the quality of the images. Undersampled MRI allows for fewer measurements in Fourier-space, thereby reducing the scan time by 4-8 times. However, in this approach, some information is lost according to the Nyquist-Shannon sampling theorem. The main hypothesis of this study is the possibility of using general information from the scan space through machine learning to mitigate this problem.

1 Introduction

2 Problem statement

1. $(\mathrm{M}, \mathrm{Y}) \in \mathcal{D}$ – Dataset
2. $\mathrm{M}, \mathrm{Y} \in \mathbb{R}^{k \times k}$, $\mathrm{Y} = \mathcal{F}(\mathrm{M})$ – MRI image and its Fourier transformation
3. $I : \mathbb{R}^{k \times k} \longrightarrow \mathbb{R}^{k \times k}$ – Filter function, which preserves other elements and zeroes other

The goal is to find function $B^* : \mathbb{R}^{k \times k} \longrightarrow \mathbb{R}^{k \times k}$ which minimizes the risk over the image distribution:

$$B^* = argmin_B R(B)$$

where

$$R(B) = \mathbb{E}_{\mathrm{Y},\mathrm{M}}[L(B(I(\mathrm{Y})), \mathrm{M})]$$