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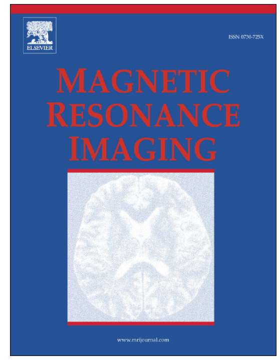

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Multi-echo Reconstruction from Partial K-space Scans via Adaptively Learnt Basis

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Abstract – In multi-echo imaging, multiple T1/T2 weighted images of the same cross section is acquired. Acquiring multiple scans is time consuming. In order to accelerate, compressed sensing based techniques have been proposed. In recent times, it has been observed in several areas of traditional compressed sensing, that instead of using fixed basis (wavelet, DCT etc.), considerably better results can be achieved by learning the basis adaptively from the data. Motivated by these studies, we propose to employ such adaptive learning techniques to improve reconstruction of multi-echo scans. This work will be based on two basis learning models – synthesis (better known as dictionary learning) and analysis (known as transform learning). We modify these basic methods by incorporating structure of the multi-echo scans. Our work shows that we can indeed significantly improve multi-echo imaging over compressed sensing based techniques and other unstructured adaptive sparse recovery methods.

Keywords – multi-echo imaging, multi-contrast imaging, compressed sensing, dictionary learning, transform learning

1. Introduction

Application of compressed sensing (CS) techniques in magnetic resonance imaging is a well known area. It has been developing for the past decade since the publication of seminal work by Lustig et al [1]. Basically the objective is to reduce the data acquisition time. This is achieved by partially sampling the K-space. Mathematically this is expressed as,

$$y = RFx + \eta,\ \ \eta \sim \mathrm{N}\left(0,\sigma^2\right) \tag{1}$$

Here x is the underlying image to be reconstructed, F is the Fourier mapping between the image and the K-space, R is the restriction operator which corresponds to the partial sampling process, y is the acquired K-space data and η is the system noise known to be Normally distributed.

This is a typical under-determined linear inverse problem since the number of K-space scans acquired are fewer than the size of the image. Hence CS plays a role in recovering x. CS assumes that the image is