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Accelerated parallel imaging by transform coding data compression with *k-t* SENSE

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Abstract— **The theory and implementation of the *k-t* approach (*k-t* BLAST and *k-t* SENSE) are reviewed in the context of transform coding. The *k-t* approach exploits the information redundancy in typical time series of magnetic resonance images that depict anatomy and/or functional parameters. By utilizing this redundancy, it opens up the opportunity for significant acceleration, which in turn allows for scan time reduction, improvements in spatial or temporal resolution, or extended volume coverage for a given acquisition time.**

I. Introduction

Acquisition speed is a crucial factor in dynamic applications of Magnetic Resonance Imaging (MRI), such as cardiac imaging. Traditionally, the MR image formation process involves sequential encoding of the image contents by magnetic field gradients. Thus, the acquisition speed is determined by the rate of change of the encoding magnetic fields. However, safety regulations impose an upper limit to this rate of change, thereby preventing further, necessary acceleration of dynamic imaging.

Over the past decade, acquisition speed has improved considerably with the development of parallel imaging [1–3], which takes advantage of the inhomogeneous sensitivities of phased-array coils to eliminate some of the encoding steps. Parallel imaging is conceptually similar to filter banks in digital signal processing [4]. In practice, it is only possible to achieve accelerations of two- to four-fold along each phase-encoding direction at clinical field strengths and typical object sizes, due to electromagnetic considerations [5].

The acceleration achievable with parallel imaging can be augmented significantly by combining it with the concept of transform coding [6]. Recently, the *k-t* SENSE method was developed based on this idea [7]. It allows considerable acceleration by exploiting the information redundancy in typical time series of images that depict anatomy and/or functional parameters. In order to make the *k-t* approach completely general, it was proposed to acquire an additional set of training data [8], which comprises a low-resolution image series of the dynamic object being investigated. The additional training data constrain the reconstruction problem in an adaptive manner, thereby avoiding any unnecessary assumptions to be made about the spatiotemporal nature of the dynamic object. This renders the *k-t* approach robust in a wide range of dynamic imaging applications. Nevertheless, as shown by the work of other groups [9], it is feasible and also desirable in certain applications to forgo the training data by making slight assumptions about the signal distribution in order to maximize the achievable acceleration. In this work, the theory and implementation of the *k-t* approach are reviewed.

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