Efficient Excitation of Magnetization for Compressed Sensing MRI

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PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	9,285,445	03/15/2016	2010-262

BACKGROUND

Existing magnetic resonance imaging (MRI) methods are built around the 40-year old concept that MRI data should be the Fourier transform of the desired image. Compressed sensing (CS) technology for reconstructing images and other data from incomplete data has the potential to reduce MR data acquisition time. The ideal raw data for CS reconstruction is randomly sampled data rather than the Fourier sampled data used by the current technologies.

TECHNOLOGY DESCRIPTION

A UC San Diego (UCSD) researcher has developed a fast and efficient way to excite nuclear spins in the MR imaging process to generate randomly sampled data. The invention can potentially replace most existing MRI data acquisition strategies. The approach simultaneously produces high steady-state signal, high A/D duty cycle, and pseudo-random sampling functions, and is therefore both SNR efficient and readily amenable to CS reconstruction. The method also allows for extraction of proton density, T1, T2, and B0 maps from a single data set.

The UCSD invention can achieve high information efficiency on data acquisition. It generates random transverse (observable) magnetization using very short random RF pulses (~10 microseconds each), applied approximately once every millisecond, with continuous gradients and data acquisition between RF pulses, for a time efficiency of 99 percent versus 20-50 percent for conventional balanced steady-state free precession (SSFP).

The key methods consist of:

A rapid train of random phase low-flip angle RF pulses can generate large steady state transverse magnetization.
Gradients applied between these RF pulses that have a pseudorandom distribution weighted towards the center of k-space and will generate a distribution of coherences that result in a pseudorandom spatial pattern of excitation.

APPLICATIONS

This is a general approach to data acquisition for MRI and can potentially replace most existing MRI imaging strategies.

ADVANTAGES

- Reduction in time needed for data acquisition.
- High SNR efficiency.
- Pseudorandom excitation, which approaches optimality for CS.
- Low RF power deposition (low specific absorption rate): relative to balanced SSFP, UCSD's 2° RF pulses deposit approximately 15 times less RF power than the 30° pulses of balanced SSFP.
- Efficient use of gradients with simultaneous estimation of proton density, relaxation times, and resonance offset using CS methods.

STATE OF DEVELOPMENT

The principles have been demonstrated with reconstruction of simulated data.

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OTHER INFORMATION

KEYWORDS

MRI, fMRI, CS, compressed sensing

CATEGORIZED AS

- Medical
  - Diagnostics
  - Imaging

RELATED CASES

2010-262-0

RELATED MATERIALS

Available upon request.

Wong EC Efficient Randomly Encoded Data Acquisition for Compressed 2010. ISMRM 18th Annual Meeting Abstract # 4893.

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