TPI-SENSE for efficient 3D proton/non-proton MR imaging

Published date: Aug. 28, 2016

Technology description

TPI-SENSE is a parallel-imaging pulse sequence for efficient three-dimensional (3D) magnetic resonance imaging (MRI) on patients that relies on an extension of the Twisted Projection Imaging (TPI) data acquisition scheme (created by Dr. Boada et al and released into public domain circa 1997). TPI is the most efficient means to sample the spatial frequency domain while attaining ultra-short echo times. Because of its ultra-short echo time capabilities, TPI is ideally suited for non-invasively performing proton or non-proton (e.g., sodium) MR imaging of very-short T2 species in the human body (T2<10 ms) which has important applications for the diagnosis of and monitoring of diseases such as stroke and cancer. TPI-SENSE employs an array of four or more coils and collects undersampled TPI MRI data sets, with high scan time efficiency of three-fold or higher. The undersampled TPI data are then transformed into MRI images using sensitivity encoding (SENSE) image reconstruction algorithms. The TPI trajectory samples the k-space in a spherical volume using concentric cones with equally-spaced polar angles.

Individual cones are further discretized using TPI lines with uniformly-spaced azimuthal angles. Each of these TPI lines starts at the center and extends to the edge of the k-space along a straight radial segment followed by a twisted radial segment. This intrinsic three-dimensional sampling scheme produces an isotropic resolution in the three spatial directions, which is suitable for the visualization of the imaged tissues at different view angles.

In the TPI-SENSE sequence, short T2-induced MR signal decay is minimized by using very short excitation pulse (<0.5 ms) and very short data acquisition delay (<0.2 ms, limited only by the hardware). The multiple coils are used to provide additional spatial encodings and to indirectly compensate for the missed TPI lines. The TPI-SENSE sequence can be installed in clinical multi-channel MRI scanners without any extra hardware requirements.

Advantages

1. TPI-SENSE has higher (5) scan-time efficiency than conventional MR imaging.
2. TPI-SENSE has 37% higher signal-to-noise ratio (SNR) than Cartesian data acquisition.

3. TPI-SENSE decreases slew rate requirement and thus has shorter readout time (less MR signal loss) than conventional TPI trajectory.

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