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Designing 2D and 3D Adiabatic Pulses

IP Status: Issued US Patent; **Application #:** 15/493,959

Multi-Dimensional Adiabatic Pulse Design Using a Sub-Pulse Approach

A new method designs and implements spatially selective, multidimensional adiabatic radio frequency (RF) pulses for use in magnetic resonance imaging (MRI). Spatially selective inversion is achieved adiabatically in both two- and three-dimensional (2D and 3D) regions of interest. The multidimensional adiabatic pulses are designed by dividing a parent adiabatic pulse into 2D selective sub-pulse elements. Selective excitation is achieved by the sub-pulses while the phases and amplitudes of the sequence of sub-pulses are prescribed according to an adiabatic full passage (the parent adiabatic pulse). The approach can be extended to 3D by applying blips along the remaining direction between sub-pulses.

Complete Spatiotemporal Properties

Previous methods for designing a 2D adiabatic pulse use 1D amplitude-modulated sub-pulses to define a slice in one spatial direction and frequency- and amplitude-modulation of these consecutive sub-pulses to define a slice in a second spatial direction. By using 2D sub-pulses, this new approach enables 3D selection in space. By exploiting the spatiotemporal properties of this 3D excitation, it is possible to perform 3D spatiotemporally-encoded MRI (rather than exciting the entire object simultaneously). Furthermore, it offers the flexibility to choose the desired modulation method in either direction and/or to choose the desired shape of the selective excitation (square, cylinder, etc. Other advantages include significant acceleration in STEREO (scan-time), better image fidelity, compensation for B0 inhomogeneities in 1D, and volumetric slab selection for SWIFT.

BENEFITS AND FEATURES:

- Spatially selective, multidimensional adiabatic radio frequency (RF) pulses
- 2D and 3D adiabatic pulse design
- Complete spatiotemporal properties
- Uses a sub-pulse approach
- Significant acceleration in STEREO (scan-time)
- Image fidelity – better k-space trajectory to reduce saturation in center of k-space
- Can compensate for B0 inhomogeneities in 1D
- Provides volumetric slab selection for SWIFT (faster, higher resolution)
- Software implemented on MRI scanner
- Potentially disruptive (low-cost) technology

APPLICATIONS:

- May enable anatomy specific (breast, brain) scanners
- Could expand customer base beyond hospitals and imaging centers
- Selectively exciting a desired shape adiabatically can be used in applications such as navigator, in which the pulse can be tailored to a target organ to track anatomic motion.
- Can be used to selectively excite a volume of interest (e.g., the heart) to permit high resolution imaging in the volume in reduced time (i.e., since the field-of-view is reduced by volume selection, the number of k-space samples required to achieve a given resolution is reduced).

Technology ID
20160260

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Phase of Development - Pilot scale demonstration

Researchers

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Publications

Designing 3D selective adiabatic radiofrequency pulses with single and parallel transmission

Magnetic Resonance in Medicine, 2017 May 12