PatLoc: MR Imaging with Non-bijective and Curvilinear Magnetic Encoding Fields

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Background: Spatial encoding in MRI is conventionally performed with magnetic encoding fields which vary linearly over the field-of-view. Physiological limitations of gradient performance of such constant gradients have led to the PatLoc imaging concept, where the requirement of gradient linearity is relaxed in favor of arbitrarily shaped nonlinear, non-bijective spatial magnetic encoding fields (SEMs). The application of purely non-bijective SEMs leads to ambiguous encoding and adapted parallel imaging techniques with multiple receive coils are used to resolve the resulting aliasing.

Outline: After introducing to the concept of PatLoc imaging the current hardware at our lab is presented. The PatLoc imaging process is illustrated and modeled with a fundamental signal equation as the basis of reconstruction.

First, the reconstruction problem is formulated for a 2D imaging setup, where only two pure PatLoc SEMs are involved. It is shown that in this case, the reconstruction problem can be reformulated to a form known from SENSE reconstruction. Based on this equivalency relation, it is possible to derive the basic imaging properties. The most evident property is that resolution is no longer homogeneous throughout the field-of-view.

The reconstruction problem is then extended to an imaging case, where more than two SEMs are used to encode a 2D image. The Fourier transform is no longer applicable with adverse effects on reconstruction time. In order to get the growing complexity under control, to predict image properties such as image resolution, a linear approximation to the phase factor is shown to be effective.

The remaining part of the talk is devoted to several examples, where the PatLoc SEMs are used for different imaging purposes.

- Concept: Hennig J, Welz AM, Schultz G, Korvink J, Liu Z, Speck O, Zaitsev M. PatLoc: Imaging in non-bijective, curvilinear magnetic field gradients: A concept study. MAGMA 2008: 21(1-2): 5 - 14.
- Theory/Reconstruction: Proc. ISMRM 2008: #786, 2992; 2009: #563, 762 (→ MRM , in press), 4557; 2010: #82, 546, 548.
- Hardware/Safety: Proc. ISMRM 2008: #1163, 1164; 2009:#2988, 3052, 3061, 3073; 2010: #1527, 3946.
- Extensions/Applications: Proc. ISMRM 2010: #547, 4929.