Isotropic Multispectral qMRI with the Mixed-TSE Pulse Sequence and SENSE: Implications for Synthetic-MRI

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Purpose: Isotropic imaging is highly desirable because it allows multiplanar reconstruction at the native spatial resolution. One application of qMRI that can benefit from isotropic resolution is synthetic-MRI (1-3). The purposes of this work were to develop a pulse sequence for isotropic multispectral (PD, T1, T2) qMRI with clinically compatible scan times and to study its potential for multiplanar synthetic-MRI.

Experimental Methods: A variant of the mixed-TSE pulse sequence was implemented with parallel imaging (SENSE) using a 3T clinical MRI scanner (Philips Medical Systems, Cleveland, OH). Key imaging parameters: isotropic voxel=1.25mm^3, 140 contiguous slices, TR=26.57s, TE1,2eff=8.8 and 110ms, TI1,2=700ms and 13.28s. Mixed-TSE is a four time point pulse sequence which generates four differently T1- and T2-weighted images per slice thus allowing for multispectral qMRI in PD, T1, and T2.
The sagittal directly acquired images were processed with in-house developed PD, T1, and T2 algorithms programmed in Mathcad (PTC, Needham, MA). The qMRI maps were read into a synthetic-MRI contrast navigation application programmed in Mathcad (PTC, Needham, MA), which allows for continuous contrast navigation by varying the levels of T1 and T2 weightings. It also allows for spatial navigation along the three orthogonal planes (axial, coronal, and sagittal). The synthetic-MRI navigation program has a mathematical engine built upon solutions of the Bloch equations and has provisions for continuously varying the following pulse sequence control variables: TE, TR, TI, and flip angle.

Results: Selected PD, T1, and T2 maps are shown in ***Figure 1***: the multiplanar reformation maps (center and right columns) have identical spatial resolution and nearly identical image quality as the ones of the native sagittal plane. PD, T1, and T2 values for selected ROIs are in excellent agreement with the accepted values at 3T (4). Synthetic MR images simulating several commonly used pulse sequences are shown in ***Figure 2*** in the native sagittal plane as well as in the coronal and axial multiplanar reformations. Specifically, the simulated pulse sequences are the standard T2-weighted spin-echo, the T2-weighted fat suppressed by inversion recovery (second row) and the T2-weighted FLAIR (third row). Similar image quality was observed across the full imaging volume and along all three imaging planes.

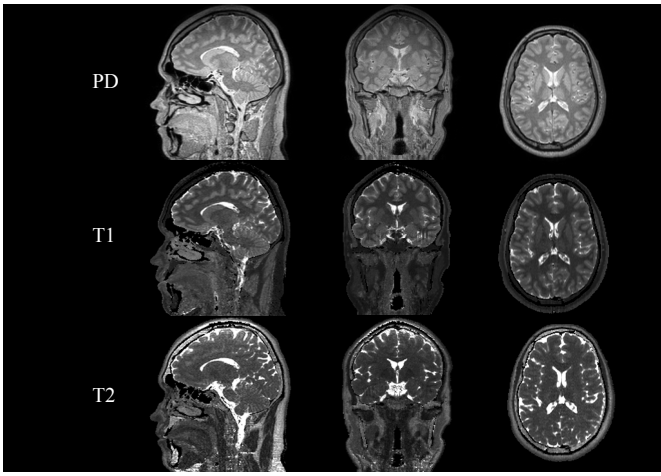

Figure 1: Multiplanar qMRI maps.

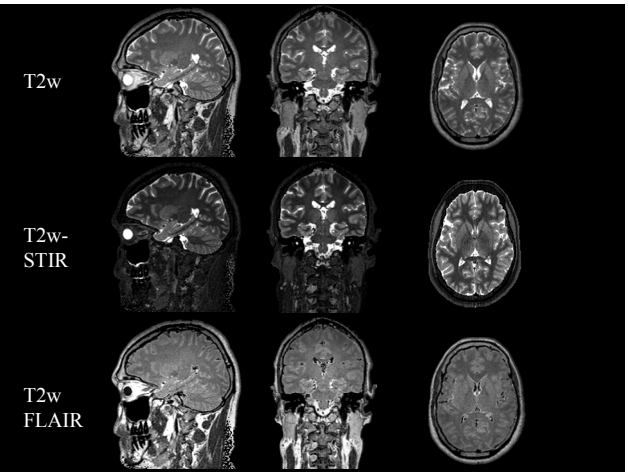

Figure 2: Multiplanar synthetic-MRI.

Conclusion: Isotropic multispectral qMRI is achievable with current MRI technology producing excellent qMRI map quality along the three orthogonal planes. High quality multiplanar synthetic MRI has been demonstrated. This work could have implications for the design of much faster clinical MRI protocols.

References

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