Highly accelerated Bloch-Siegert B1-mapping using variational modeling

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Mapping of the transmit radio frequency field B_{1+} is an important field in Magnetic resonance imaging (MRI) due to the calibration of multi-transmit systems or in the field of quantitative MRI to correct for flip angle variations in the idealized signal models. The method of Bloch-Siegert (BS) was proposed as a fast and accurate approach for this purpose exploiting the shift in resonance frequency due to an off-resonant RF-field. Nevertheless, due to the high magnitude of the BS-pulse the specific absorption rate (SAR) gets very high limiting the minimum possible acquisition time due to patient safety. The acquisition is usually performed with either positive and negative resonance offset to get rid of undesirable background phase, leading to a huge amount of redundancy in the measurement data. This redundancy and the prior knowledge about the structure of the magnitude image and the B1-map is exploited to design a proper regularization strategy to reconstruct accurate B1-maps out of highly undersampled data. We demonstrate our approach on 3D in-vivo measurements in comparison to a fully sampled reference, reaching acceleration factors of around 60 - 80, without a significant loss in accuracy. With this approach a full liver coverage during a single breath hold can be reached.