Slice Acceleration of T1 Mapping of Brain Using Multi-Band Excitation Pulses

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Introduction

Simultaneous multi-band excitation pulses have been combined with parallel imaging methods to reduce acquisition time in fMRI [1]. In the work described here, we apply these techniques to quantitative imaging where the image contrast may differ significantly from the calibration data used for the parallel imaging based slice unaliasing[2,3]. An inversion recovery (IR) EPI pulse sequence was employed to demonstrate acceleration of the acquisition in the slice dimension.

Method

All work was performed on a GE Discovery MR750, 3T MRI system on human subjects under a protocol approved by a local IRB. A Nova Medical 32 channel coil was used for signal reception and GE body coil for transmit. A multi-band excitation pulse was generated by cosine modulating a Hamming windowed, sinc pulse with a user specified duration and time-bandwidth (TBW) product. The coil sensitivity matrix used to unalias the slice is derived from calibration data acquired in one of two ways: a) conventional slices of the full data set were acquired or b) the slices in the side lobes of the multi-band pulses were phase cycled such that the slices can be separated using a discrete Fourier transform [4]. The latter offers the advantage that the RF amplitude and pulse bandwidth remain constant between calibration and acquisition phases.

Results and Discussion

The set of images in Fig. 1 are images of brain *in vivo* with inversion times ranging from 50ms to 2400ms with a TR of 3000ms. As in-plane acceleration was not used, the echo time for these images was 53.6msec. In this experiment, the calibration images used to generate the sensitivity maps were acquired using a separate acquisition employing a conventional RF pulse and no inversion pulse. Despite significant differences in contrast, the the slice separation algorithm did not introduce noticeable image artifacts. A duration of ten milliseconds and a TBW of five was chosen resulting in a maximum flip angle of 61 degrees for a three band RF pulse given the maximum B1 produced by our transmit coil. Reduction of B1 using VERSE has already been demonstrated elsewhere[5,6].

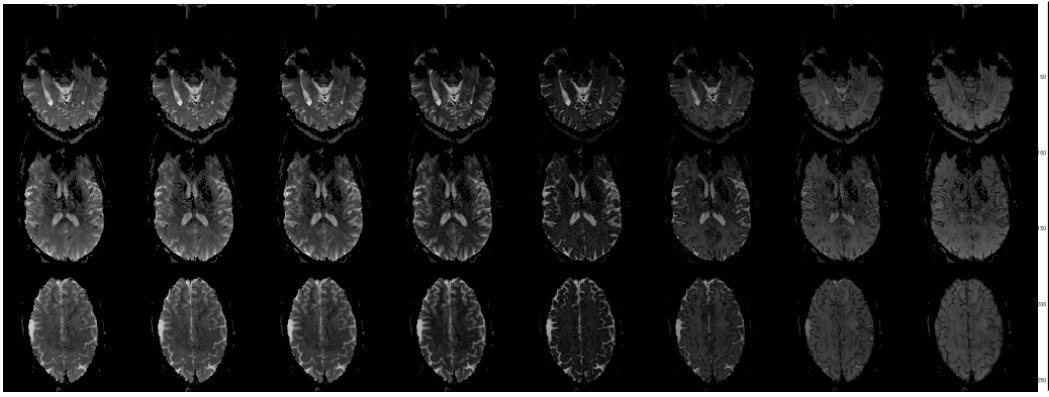

Fig.1 Three band RF excitation pulses were used to acquire images with a non-selective IR pulse. The rows are from slices separated using a SENSE algorithm. Inversion times (TI) were 50, 100, 200, 400, 800, 1200, 1800 and 2400ms.

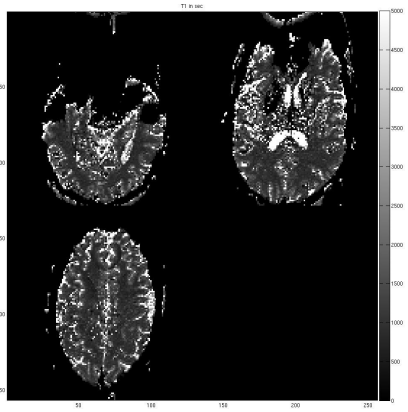

Fig. 2 A T1 map was calculated from fitting a mono-exponential to data shown if Fig.1.

Conclusion

Although in-plane acceleration was not used for the images acquired in this work, it is completely compatible with and complimentary to slice acceleration. Full brain images can be acquired at high resolution in about 75 seconds. With a careful choice of a small number of inversion times, a complete T1 map can be obtained in very reasonable acquisition times of around 4 minutes. SAR and RF amplitude limit the number of bands that can be used but variable excitation rate selective excitation (VERSE) or other methods will reduce this constraint.

References

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