parallel imaging with 3D PR(VIPR)

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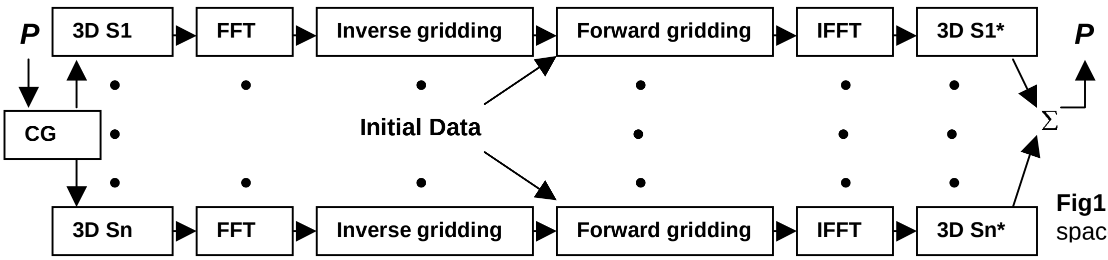
INTRODUCTION

3D PR methods such as VIPR [1] use undersampled PR trajectories to reduce the trade off between spatial and temporal resolution in CE MRA. Recently, the radial GRAPPA technique by Griswold *et al* [2] demonstrated reduced streak artifacts in 2D PR cardiac imaging. We investigate parallel imaging methods in 3D PR to reduce the structured background noise due to undersampling. We demonstrate large improvements in CNR using the conjugate gradient method described by Pruessmann *et al* [3] to a 3D PR VIPR trajectory using simulated data.

MATERIALS AND METHODS

An artificial phantom was synthesized with cylindrical tubes that form a cross in the transverse plane and extend into the longitudinal dimension as shown with the coordinate axes in Fig.2. Four-receiver sensitivity maps were generated that simulated the falloff in receiver map intensity with distance. The 3D image volume was multiplied with the sensitivity maps of each receiver, zero padded and inverse *FFTed*. The corresponding k-space data was inverse gridded onto a 3D radial VIPR trajectory to obtain individual receiver data.

The algorithm described by Pruessmann *et al* [3] is shown in Fig.1 for the first and last receivers. The forward and inverse gridding steps were modified for a 3D radial trajectory.



3D Sn* - 3D complex conjugate sensitivity map of receiver n.
CG – Performs other calculations of the CG method
3D Sn- 3D sensitivity map of receiver n.
P-Vector Residuum.

Fig1. SENSE for arbitrary k-space trajectories [3].

The initial receiver data is inputted into the *forward gridding* block at the center and the loop generates an output sum image, which is used as a vector residuum *P* in the *CG* block. The *CG* block outputs an image volume with reduced artifacts, updates the vector residuum and feeds this back into the loop for the next iteration. The de-appodization steps to compensate for gridding were accounted for in the loop.

RESULTS AND DISCUSSION

The simulated data used 25000 projections, equivalent to a reduction factor of 4 compared to the 100000 projections necessary for full sampling. The CG loop was allowed to run for ten iterations although significant improvement is achieved at the fifth iteration. The processing time was 60 minutes, which is approximately 20 times longer than a conventional VIPR reconstruction. The ratio of the tube signal to the mean background signal is higher in Fig.3b by a factor of 5 after parallel reconstruction.

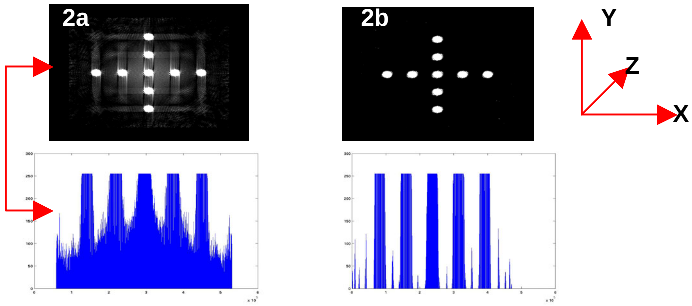


Fig.2: Intensity line plots across the center of the MIPS show the reduction in background artifacts from Fig.2a to Fig.2b.

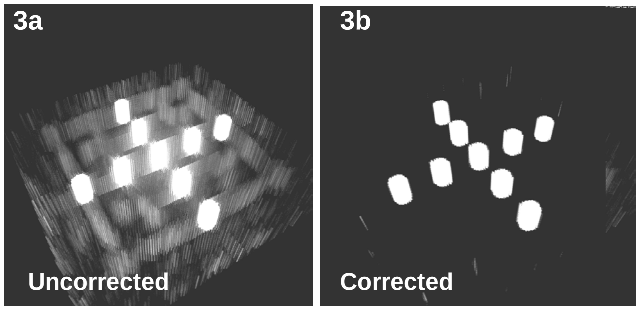


Fig.3: Higher CNR is achieved in fig.3b of these obliquely reformatted MIPS for a reduction factor of 4.

CONCLUSION

We have demonstrated the feasibility of significantly increasing CNR in VIPR through parallel imaging. Efforts to apply this algorithm on actual VIPR data are currently ongoing. Parallel imaging techniques that exploit the symmetry of the PR trajectory as described by Griswold et al [2] for 2D PR may reduce processing time.

REFERENCES

[1] Barger *et al*, MRM 48:2002 [2] Griswold *et al,* Proc. 11th ISMRM, 2349(2003) [3] Pruessmann *et al*, MRM 46:2001

ACKNOWLEDGEMENTS

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