BigBrain-MR: a new digital phantom at 100-μm resolution for MR methods development

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INTRODUCTION

BigBrain-MR is a new computational brain phantom for high-resolution MR imaging methods development [1], with:
- Diverse MR properties (T1, T2*, χ) with 100-μm anatomical detail;
- MR coil sensitivity, background field & bias field maps.

FRAMEWORK

\[ T_{1w} \text{ in vivo (600μm)} \]

\[ T_{1w} \text{ (100μm)} \]

\[ \text{Label map (100μm)} \]

\[ "T_{1w-like}" \text{ BigBrain (100μm)} \]

- Registration
- Contrast mapping
- Partial volume model

Generated contrasts & maps

\[ T_{1w} \]

\[ T_{2} \]

\[ R_{2}^{*} \]

\[ T_{2}^{*w} \]

Backgr. field QSM Coil sens. mag. Coil sens. pha.

CONCLUSION

- BigBrain-MR provides realistic MR contrasts with fine structural detail;
- The validation tests indicate that the phantom compares well against real in-vivo data – thus it is a valid simulation tool to aid the development of high-resolution imaging methods.

IN THIS WORK

- We present BigBrain-MR’s framework for creating 100μm maps based on lower-resolution in-vivo MR data and the publicly-available BigBrain dataset [2];
- We evaluate BigBrain-MR’s validity as a simulation platform in two applications: super-resolution imaging & parallel imaging reconstruction.

VALIDATION 1: super-resolution imaging

\[ \text{BigBrain-MR} \]

\[ \text{In-vivo} \]

\[ \text{Reg. factor} (k) \]

\[ \text{RMSE} \]

\[ \text{Ground truth} \]

\[ \text{Reg. factor} (λ) \]

\[ \text{TV λ = 0} \]

\[ \text{Random reg. factor} (2) \]

\[ \text{Example: CAIPI acceleration 3x3} \]

VALIDATION 2: parallel imaging reconstruction

\[ \text{BigBrain-MR} \]

\[ \text{In-vivo} \]

\[ \text{Reg. factor} (k) \]

\[ \text{RMSE} \]

\[ \text{Total variation reg.} \]

\[ \text{Wavelet reg.} \]

\[ \text{Example: CAIPI acceleration 3x3} \]


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