

I INTRODUCTION

Simulated MRI data have great value for segmentation algorithm development since they provide a large set of priors for improved classification accuracy while offering the possibility to introduce imaging anomalies to check and tune the robustness of the algorithm against them. It is possible to achieve this by leveraging a relatively small initial atlas. However, such simulated MRI are not readily available for children's heads. This along with the prevalence of adult simulated data frequently used as priors (BrainWeb^{[1][2]}), was our motivation to build an MR simulator for children.

II MATERIALS & METHODS

Head model generation and simulation

- MR-CT pair from RIRE Database^[3] and ground truth-MR pair for 1 year old from UNC Infant Atlas.^[6]
- CT-MR registration using a robust and inverse-consistent affine registration^[4].
- MR-MR registration using a non-rigid registration technique using FFD and cubic B-splines^[5].
- Skull extracted from CT image by thresholding at 700HU (hounsfield unit) and morphological post-processing.
- Scalp extracted from MR image used in MR-CT registration.
- Skull augmentation done with the registration output and neighborhood voting.
- MR Simulation of the final model was performed using a hybrid of Bloch equation and tissue template simulation that simulates image contrast, partial volume, and noise^{[1][2]}.

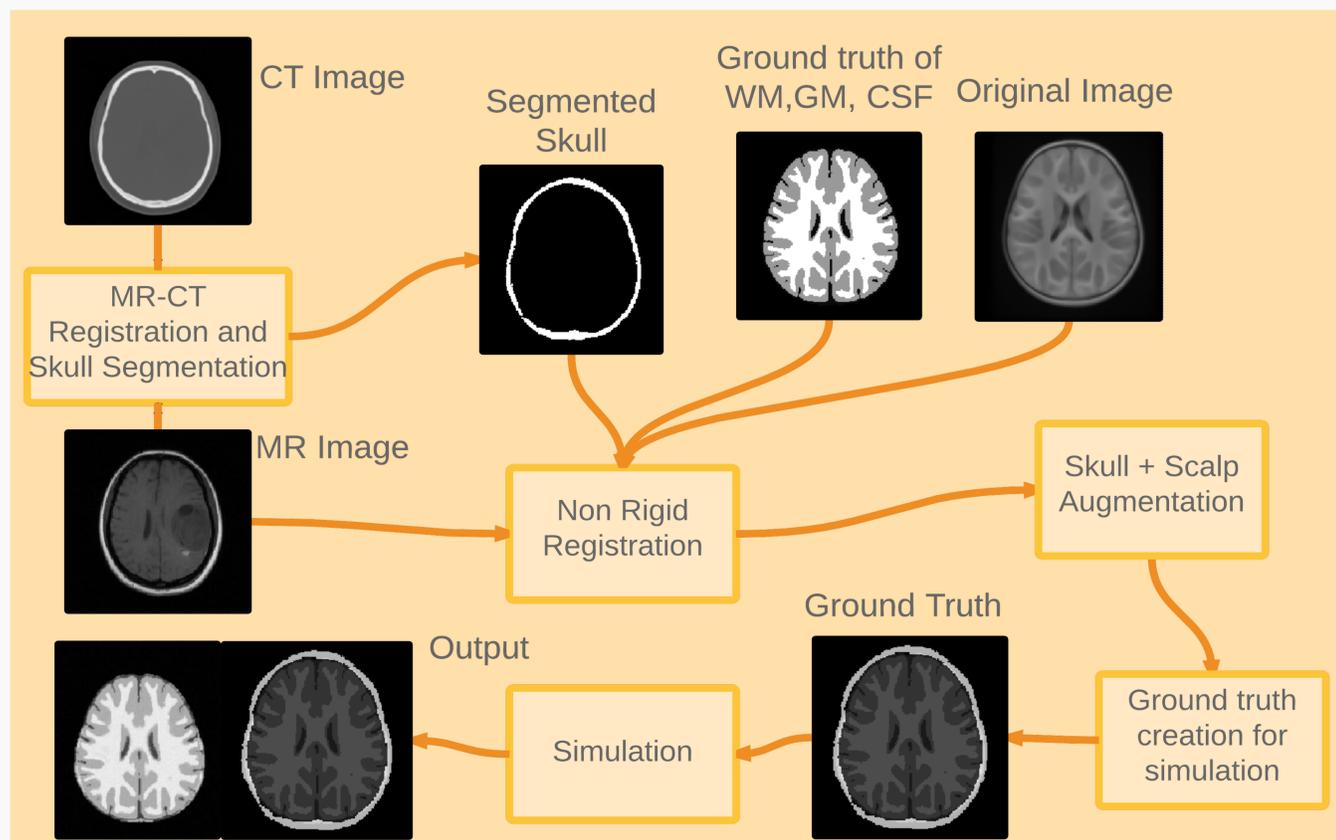


Fig. 1: Simplified overview of head model generation and simulation pipeline.

III RESULTS

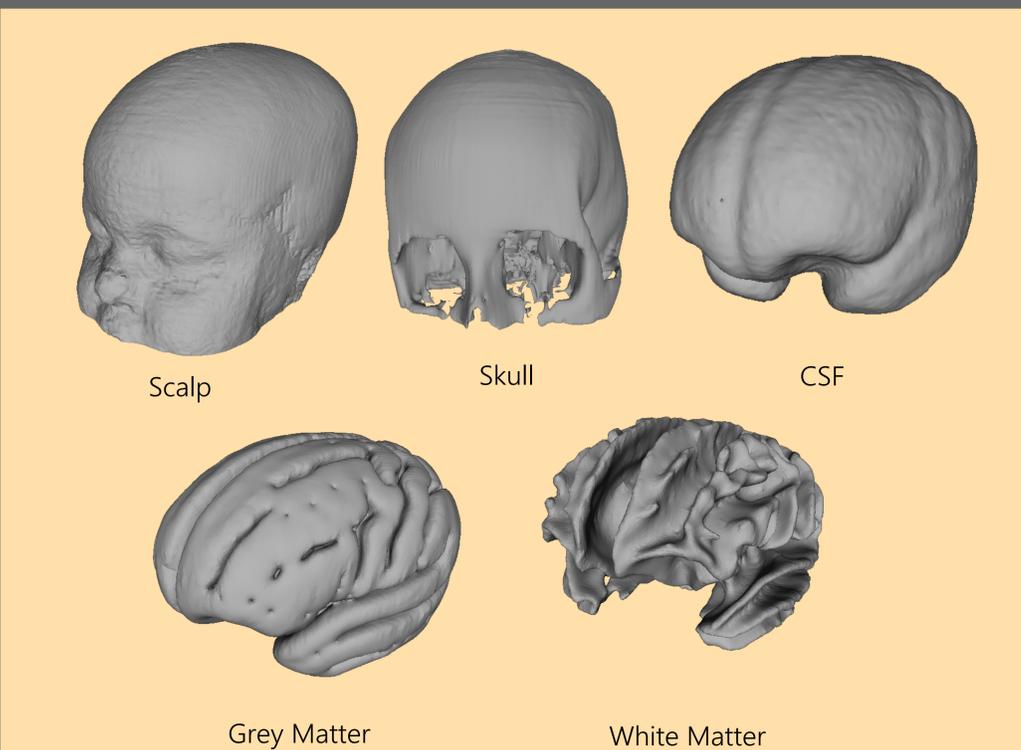


Fig. 2 : Visualization of the model used to generate the MRI

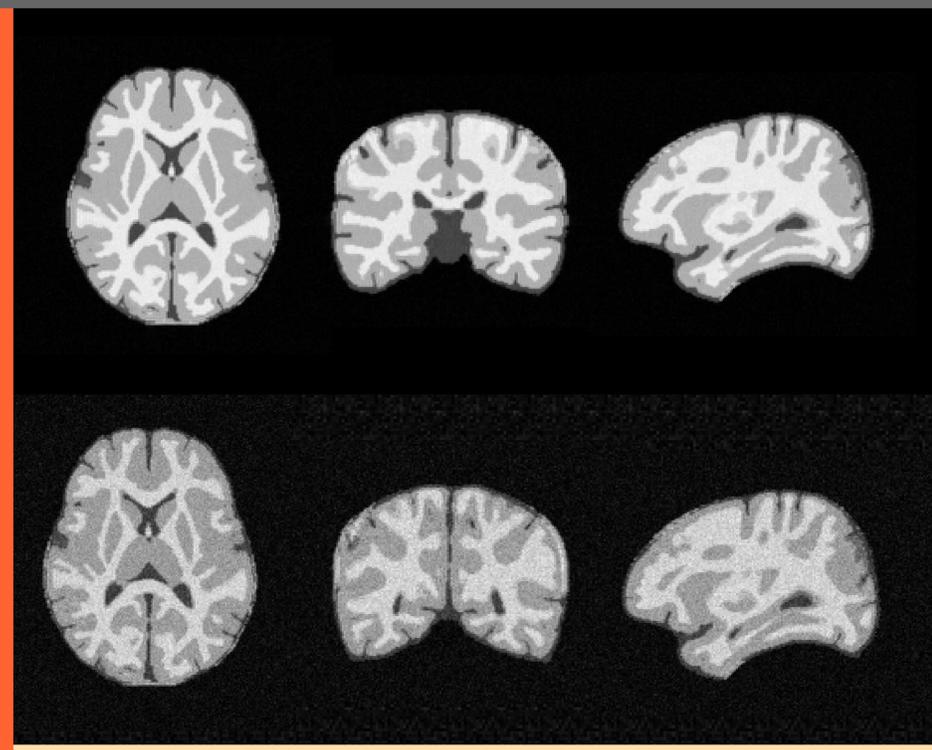


Fig. 3 : Simulated MRI using head model without noise (top) and addition of noise (bottom).

IV CONCLUSIONS

The ground-truth and MRI pair obtained from the simulation can be used as priors for segmentation algorithms of complete children's heads, with the aim of creating realistic head models for EEG/MEG source analysis.

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[2] Cocosco, Chris A., et al. "Brainweb: Online interface to a 3D MRI simulated brain database." NeuroImage 1997.

[3] National Institutes of Health. "Retrospective Image Registration Evaluation." Vanderbilt University, Nashville (TN), USA (2003).

[4] Rivest-Hénault, David, et al. "Robust inverse-consistent affine CT-MR registration in MRI-assisted and MRI-alone prostate radiation therapy." Medical image analysis 23.1 (2015): 56-69.

[5] Modat, Marc, et al. "Fast free-form deformation using graphics processing units." Computer methods and programs in biomedicine 98.3 (2010): 278-284.

[6] Shi, Feng, et al. "Infant brain atlases from neonates to 1-and 2-year-olds." PloS one 6.4 (2011): e18746.