UNC SCHOOL OF MEDICINE | BRIC BIOMEDICAL RESEARCH IMAGING CENTER

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#902

GENERATION OF ANATOMY-REALISTIC 4D INFANT BRAIN ATLASES WITH TISSUE MAPS USING GENERATIVE ADVERSARIAL NETWORKS

Kaibo Tang, Liangjun Chen, Zhengwang Wu, Fenqiang Zhao, Ya Wang, Weili Lin, Li Wang, Gang Li

Department of Radiology and Biomedical Research Imaging Center, University of North Carolina at Chapel Hill, Chapel Hill, NC, 27599 USA

Introduction

- **Brain development during infancy**
  - Significant **structural and volumetric** changes.
- **Infant brain atlas construction**
  - Crucial yet challenging to generate **spatio-temporal (4D)** volumetric atlases with **continuously sampled** time points.
- **Infant brain MR images (T1w/T2w)**
  - **Low tissue contrast** and **dynamic change** in appearance.

Contribution

- Provide **explicit guidance** from tissue maps to help generate **anatomically more realistic** intensity atlases.
- Produce **tissue segmentation maps** alongside intensity atlases.
- Affinely scale the predicted atlas automatically to accurately **reflect volumetric change** during early brain development.

Method

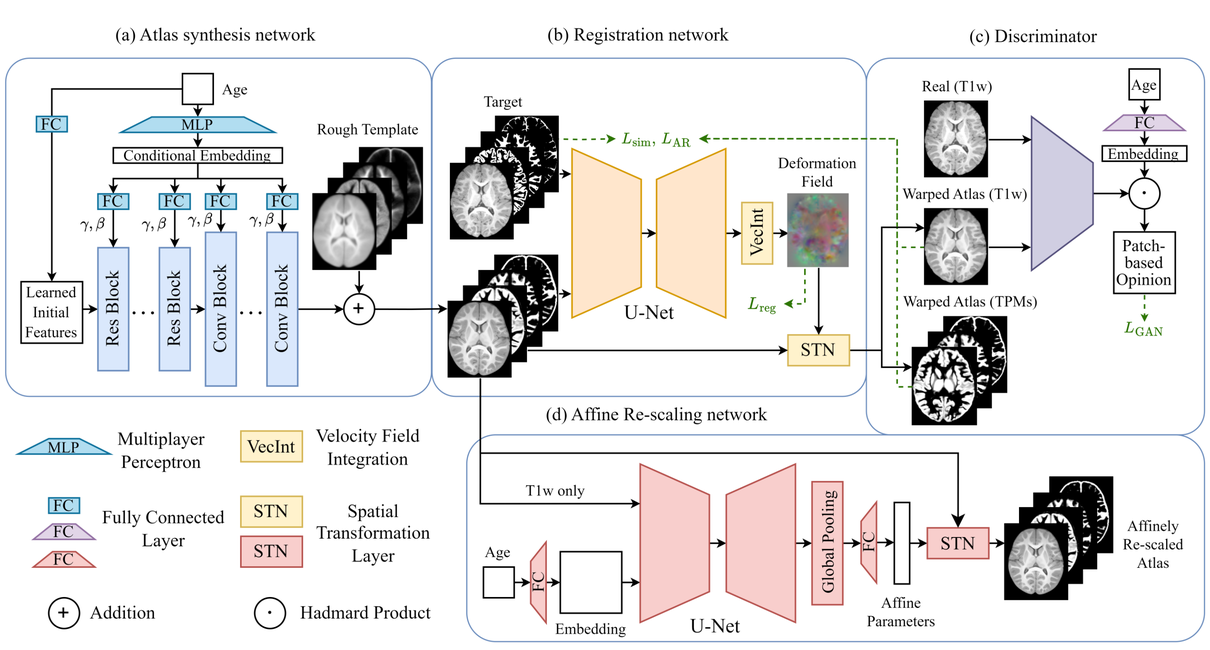

Fig. 1. An illustration of the proposed 4D atlas construction framework.

Experiments

- **Dataset:** 699 scans (T1w) from 322 subjects from the UNC/UMN Baby Connectome Project (BCP) [1].
- **Preprocessing:** Bias-corrected, skull-stripped, and segmented into white matter (WM), cortical gray matter (GM), and cerebrospinal fluid (CSF) using iBEAT V2.0 [2].
- **Comparison:** Atlas-GAN [3].
- **Evaluation Metric:** Dice Similarity Coefficient (DSC).

Results

Table 1. Quantitative evaluation of the proposed framework (Ours) and Atlas-GAN.

	DSC, %, $\bar{x}(s)$		
	WM	GM	CSF
Atlas-GAN	56.96 (2.39)	51.28 (2.61)	34.17 (3.71)
Ours	**81.39 (1.86)**	**83.90 (2.32)**	**60.22 (4.68)**

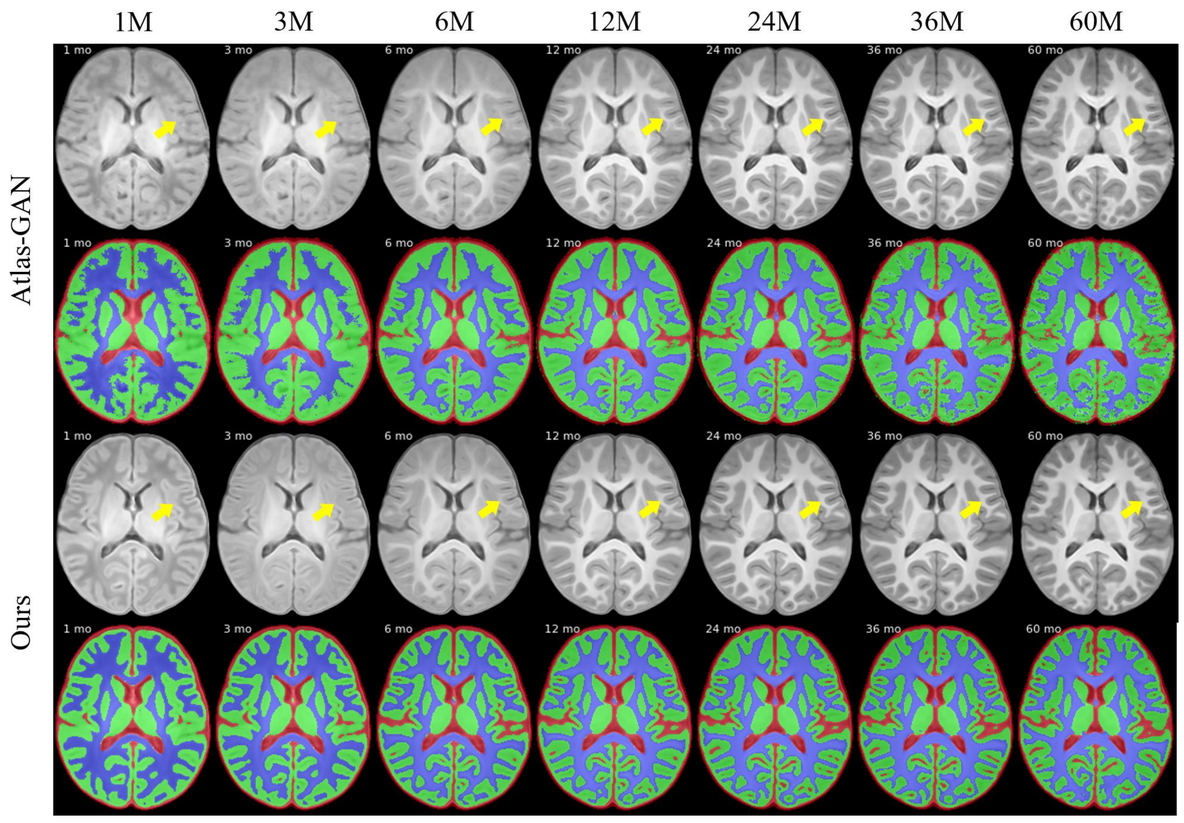

Fig. 2. Visual comparison of the proposed atlases at representative ages with tissue segmentation maps (Ours) and Atlas-GAN.

Results

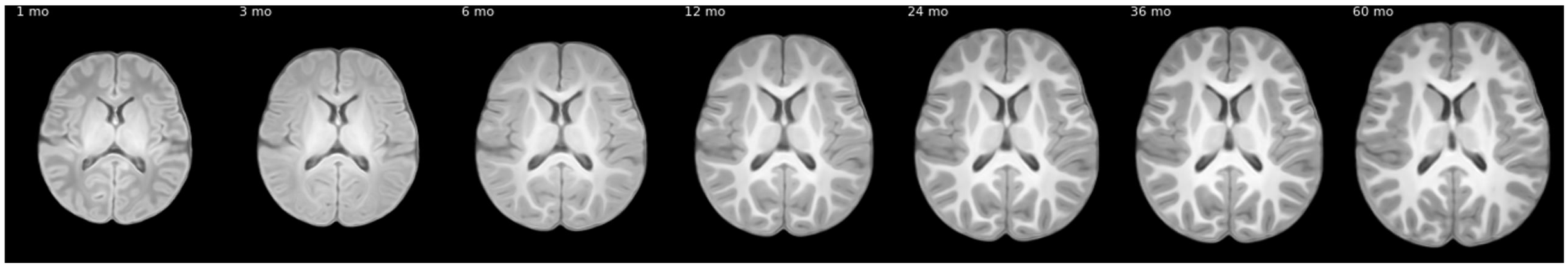

Fig. 3. Generated atlases at representative ages re-scaled from the population common space to their age-specific spaces by the affine re-scaling network.

Acknowledgments

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References

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2. L. Wang, et al., "iBEAT V2.0: A Multisite-applicable, Deep Learning-based Pipeline for Infant Cerebral Cortical Surface Reconstruction," *Nature Protocols*, vol. 18, no. 5, pp. 1488–1509, May 2023.
3. N. Dey, et al., "Generative Adversarial Registration for Improved Conditional Deformable Templates," in *ICCV 2021*. Oct. 2021, pp. 3909–3921, IEEE.