Unsupervised Multi-modal Medical Image Registration via Invertible Translation
Supplementary Material

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This document provides additional materials to supplement our main manuscript. An additional ablation study on the effect of INN in INNReg is performed in Sec. 1. We add one more comparison experiment, CocycleReg, in Sec. 2. Multimodal images with real deformation are considered in Sec. 3.

1 Additional Ablation Study

We conduct an additional ablation experiment, where we replace the INN with CycleGAN [2] in INNReg. Table 1 shows the quantitative results of this ablation study, and Fig. 1 shows the qualitative results.

Table 1: Quantitative results of the additional ablation experiment.

T1/T2	SSIM↑	NCC↑	DICE↑	HD95↓	Smooth↓	Parameters
CycleGAN	89.288	98.131	86.589	**100.925**	**0.054**	28.614M
INN	**90.555**	**98.746**	**87.117**	101.371	0.101	**6.791M**

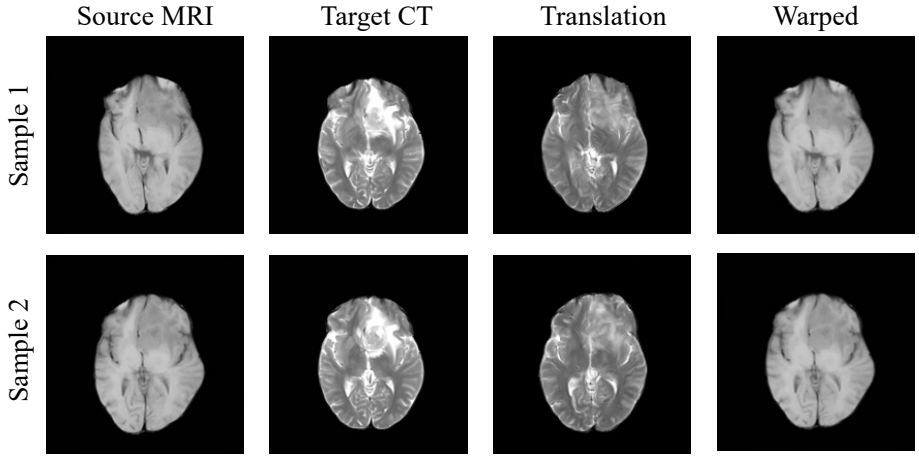

Fig. 1: Visualization results of the additional ablation experiment.

Compared to the CycleGAN-based method, INNReg is better or comparable except in smoothness. However, CycleGAN involves two generators and two discriminators, while INN includes only a reversible network, leading to a much lower model complexity. Moreover, as per our visualization results, the CycleGAN-based method suffers from structural inconsistency in the translation process, which is the main issue we have solved in this work.

2 Additional Comparison Experiment

We reproduce one more translation-based multimodal image registration method, CocycleReg [1], on the MRI T1/T2 dataset and summarized the quantitative and qualitative results in the Table 2 and Fig. 2, respectively.

Table 2: Quantitative results of the additional comparison experiment.

T1/T2	SSIM↑	NCC↑	DICE↑	HD95↓	Smooth↓	Parameters
CocycleReg	83.779	95.597	64.789	103.077	0.357	28.365M
INNReg	**90.555**	**98.746**	**87.117**	**101.371**	**0.101**	**6.791M**

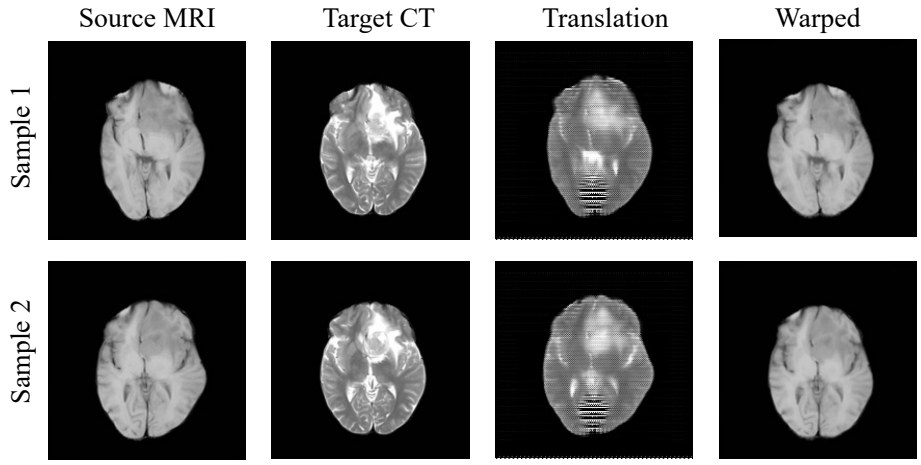

Fig. 2: Qualitative results of the additional comparison experiment.

We see that INNReg outperforms CocycleReg across all metrics. Since the original paper of CocycleReg manually selected T1/T2 data for experiments, our CocycleReg results may not be as good as those in the original paper.

3 Additional Test on Real Deformation

We conduct an initial experiment to test the INNReg on real deformation. Specifically, we randomly selected unpaired multimodal images from different subjects

and inputted them to the INNReg. The visualization results are shown in Fig. 3.

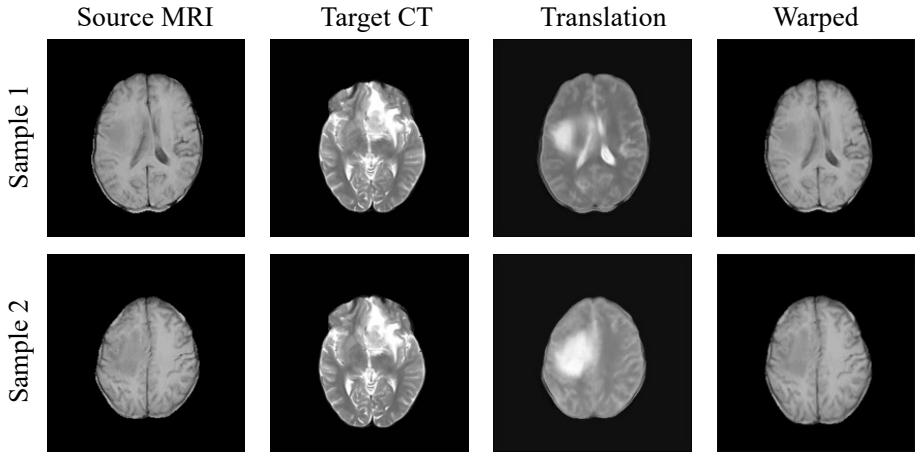

Fig. 3: Visualization results of real deformation samples.

Our method achieves satisfactory performance in real deformation settings, demonstrating the generalization capability of the INNReg.

References

1. Lian, C., Li, X., Kong, L., Wang, J., Zhang, W., Huang, X., Wang, L.: Cocyclereg: Collaborative cycle-consistency method for multi-modal medical image registration. Neurocomputing **500**, 799–808 (2022)
2. Zhu, J.Y., Park, T., Isola, P., Efros, A.A.: Unpaired image-to-image translation using cycle-consistent adversarial networks. In: Proceedings of the IEEE international conference on computer vision. pp. 2223–2232 (2017)