MuTri: Multi-view Tri-alignment for OCT to OCTA 3D Image Translation

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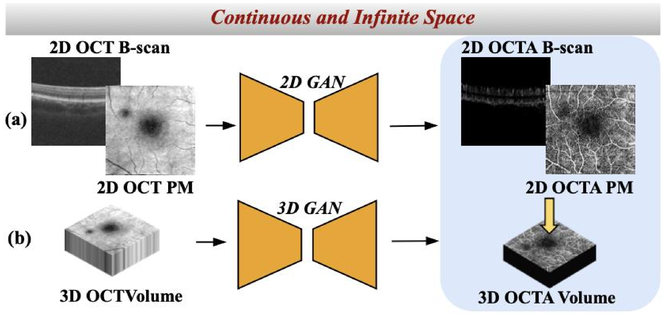
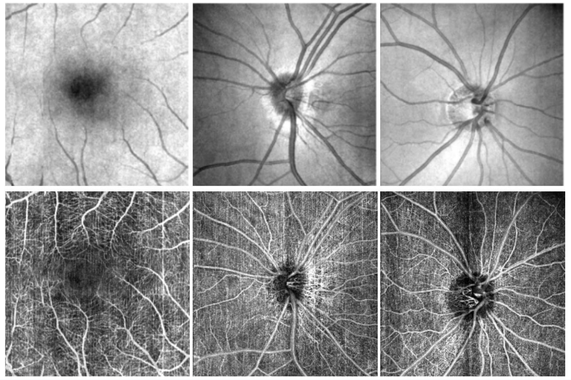
Task and Challenges

1 Previous OCT to OCTA 3D Image Translation:



2 Challenges of this task:

- ✓ It is challenging to learn the direct mapping from the OCT to the OCTA domain in an infinite and continuous space, resulting in limited translation quality of OCTA.
- ✓ Depends on a pre-trained vascular segmentation model for network guidance, which is difficult to acquire due to the substantial effort required to develop well-annotated vascular segmentation datasets.

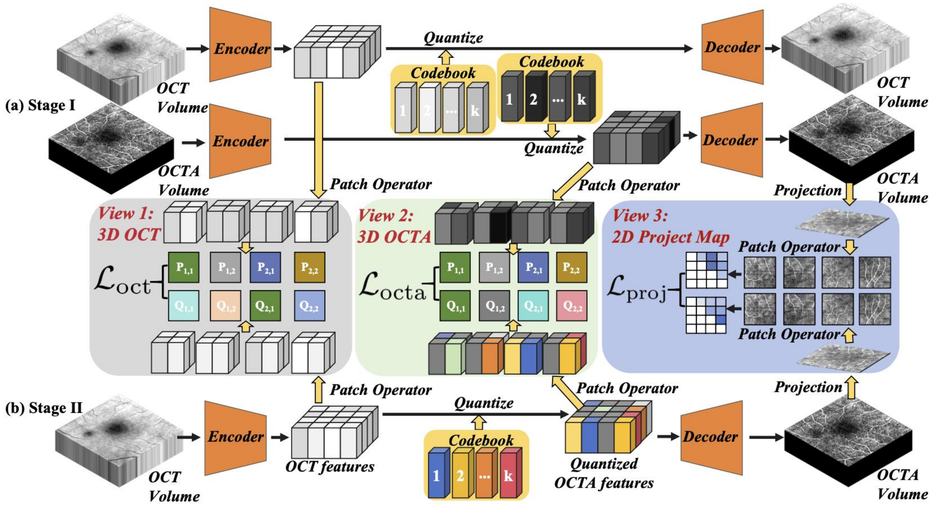


MuTri

1 Contributions:

- ✓ Propose the multi- view tri-alignment framework to enable the optimization of codebook learning for OCTA translation tasks;
- ✓ Propose contrastive-inspired semantic alignment is proposed to maximize the mutual information with the pre-trained models from 3D OCT and 3D OCTA views;
- ✓ Propose the vessel structure alignment to achieve vessel structure consistency by considering patch-level semantic correlation from the 2D OCTA projection map view;

2 Network Architecture of MuTri:



3 Training losses:

- OCT/OCTA Alignment

$$\mathcal{L}_{\mathrm{OCT}} = -\log \frac{\exp(\mathbf{Q}_{(\mathrm{i,j})} \cdot \mathbf{P}_{(\mathrm{i,j})}/\tau)}{\sum_{m=1,n=1}^{\frac{W}{S},\frac{H}{S}} \exp(\mathbf{Q}_{(\mathrm{i,j})} \cdot \mathbf{P}_{(\mathrm{m,n})}/\tau)}.$$

- Project map alignment

$$\mathcal{L}_{\mathrm{proj}} = \sum_{i,j=1,1}^{\frac{W}{S},\frac{H}{S}} \sum_{m,n=1,1}^{\frac{W}{S},\frac{H}{S}} \| \mathcal{C}^{\mathrm{octa}}_{i*\frac{H}{S}+j,m*\frac{H}{S}+n} - \mathcal{C}^{\mathrm{oct2octa}}_{i*\frac{H}{S}+j,m*\frac{H}{S}+n} \|.$$

Experiments and Analysis

Table 1. Comparisons with the state-of-the-art OCT to OCTA image translation methods on both OCTA-3M and OCTA-6M datasets

Method	Venue	OCTA-3M			OCTA-6M		
		MAE ↓	PSNR(dB) ↑	SSIM(%) ↑	MAE ↓	PSNR(dB) ↑	SSIM(%) ↑
Pix2Pix2D [16]	CVPR	0.0968	29.59	84.59	0.0995	27.65	87.15
Pix2Pix3D [16]	CVPR	0.0883	31.58	86.24	0.0900	30.66	87.16
9B18CN UNet [21]	-	0.0918	29.34	86.04	0.1135	27.91	83.69
Adjacent GAN [24]	-	0.0906	30.89	87.14	0.1021	28.05	85.03
VQ-I2I [6]	ECCV	0.0824	31.72	87.59	0.0897	29.54	86.90
Palette [34]	SIGGRAPH	0.0814	32.42	88.24	0.0881	30.02	87.13
TransPro [25]	MIA	0.0782	32.56	88.22	0.0854	30.53	88.35
MuTri	-	**0.0707**	**34.10**	**89.86**	**0.0741**	**33.08**	**90.04**

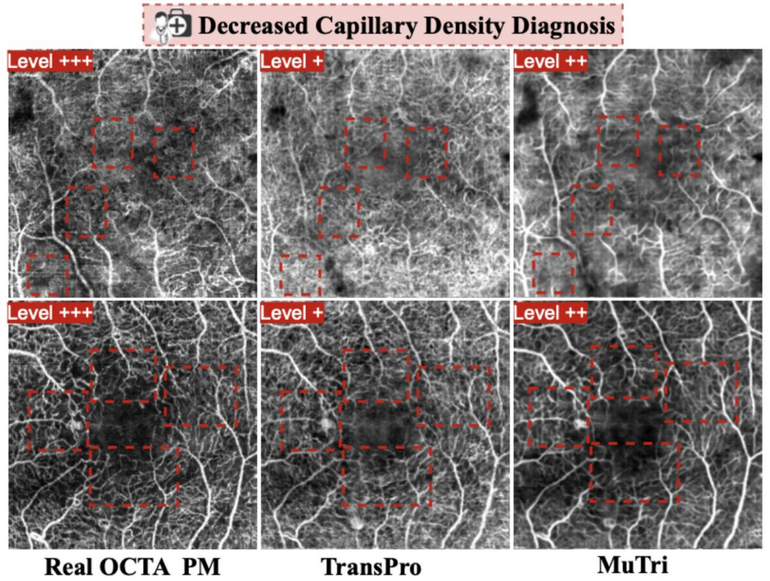


Figure 3. The decreased capillary density diseased patterns of translated OCTA projection maps (PM) annotated by an experienced ophthalmologist. The diseased pattern is presented alongside the real OCTA image, the translation results from TransPro, and our MuTri. Levels of disease are annotated from "+" to "+++", where the number of "+" denotes the degree of severity.

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