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Formula-Driven Data Augmentation and Partial Retinal Layer Copying for Retinal Layer Segmentation

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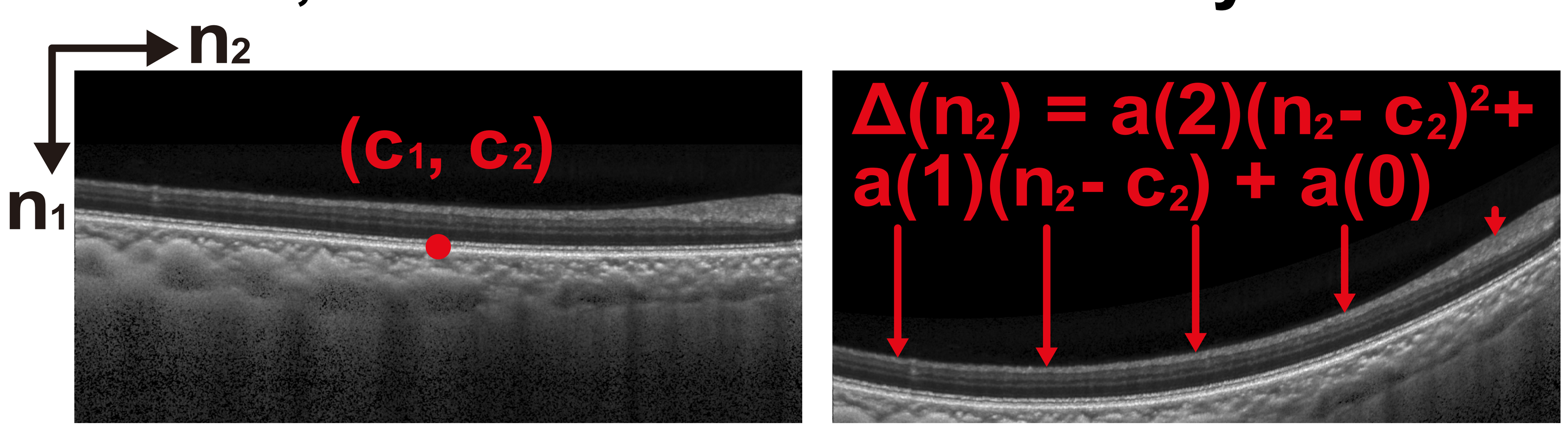
Outline

- Thickness of retinal layers is an important criterion to diagnose ophthalmopathy
- To measure the thickness, it is necessary to segment the retinal layers from OCT images
- Due to lack of labeled training data, conventional retinal layer segmentation methods [1,2] cannot deal with various retinal shapes and may falsely detect background noise as retinal layers
- To solve these problems, we propose two data augmentation methods: Formula-Driven Data Augmentation (FDDA) and Partial Retinal Layer Copying (PRLC)

FDDA

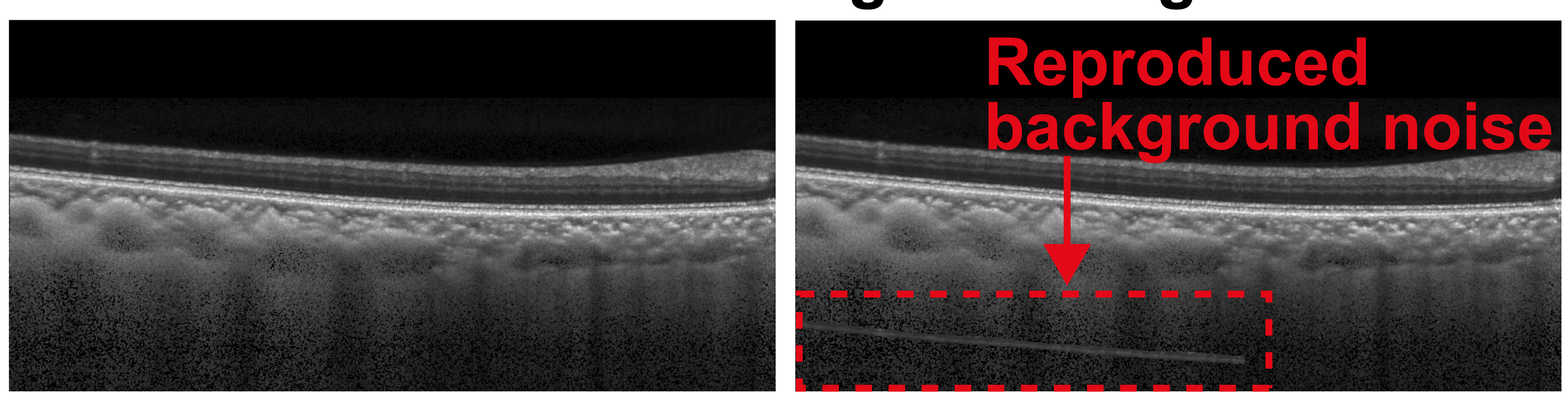
Change the position, the tilt, and the curvature of retinas, and increase the variability of retinas



Before FDDA After FDDA

PRLC

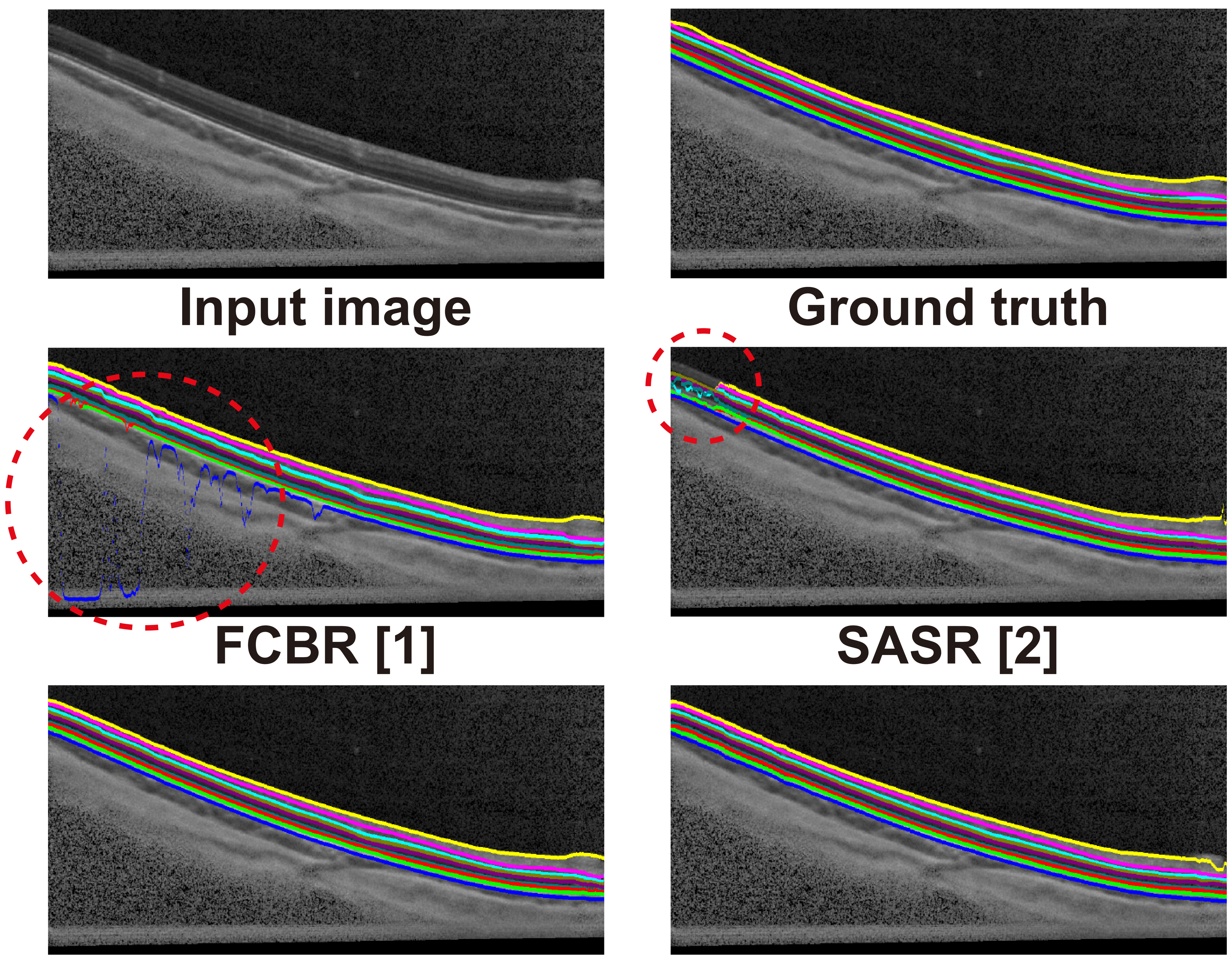
Reproduce the background noise, and reduce false detection in the background region



Before PRLC After PRLC

Experimental Results

- Evaluate the accuracy by introducing FDDA and/or PRLC to FCBR [1] and SASR [2]
- Use OCT MS and Healthy Control (MSHC) dataset [3] and Duke Cyst DME (Duke DME) dataset [4]
- Evaluate Mean Absolute Distance (MAD) between the ground truth and detected boundaries



Input image | Ground truth | FCBR [1] | SASR [2] | FCBR [1] w/ FDDA and PRLC | SASR [2] w/ FDDA and PRLC

Method	Flattening	MSHC	Duke DME
FCBR [1]	✓	2.92	6.59
FCBR [1]		3.87	6.94
w/ RandomAffine		3.76	6.44
w/ CutMix [5]		3.52	6.68
w/ FDDA		2.92	6.04
w/ PRLC		3.16	6.32
w/ FDDA and PRLC		**2.84**	**5.97**
SASR [2]	✓	**2.87**	6.54
SASR [2]		3.05	6.34
w/ FDDA		2.92	5.84
w/ PRLC		2.99	6.10
w/ FDDA and PRLC		2.90	**5.83**

[1] Y. He et al., "Fully convolutional boundary regression for retina OCT segmentation," Proc. MICCAI, pp. 120--128, Oct. 2019.
[2] H. Liu et al., "Simultaneous alignment and surface regression using hybrid 2D-3D networks for 3D coherent layer segmentation of retina OCT images," Proc. MICCAI, pp. 108--118, Sept. 2021.
[3] Y. He et al., "Retinal layer parcellation of optical coherence tomography images: Data resource for multiple sclerosis and healthy controls," Data Brief, vol. 22, pp. 601--604, Feb. 2018.
[4] S.J. Chiu et al., "Kernel regression based segmentation of optical coherence tomography images with diabetic macular edema," Biomed. Opt. Express, vol. 6, no. 4, pp. 1172--1194, April 2015.

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