Data-Driven Enhancement of Blurry Retinal Images via Generative Adversarial Networks

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Overview

Problem: We focus on the problem of blurry retinal image enhancement, where the blurriness is caused by ocular diseases.

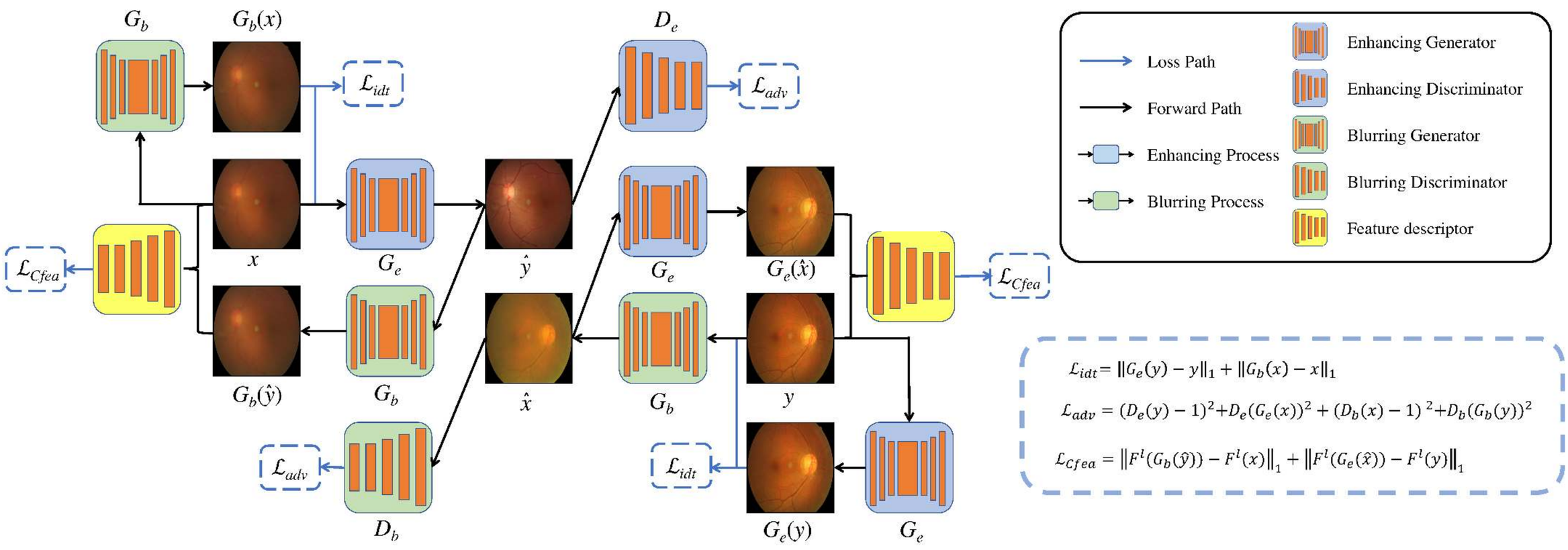
Applications:
- Improving the visual quality of retinal images for clinical diagnosis.
- Assisting automatic processing techniques to achieve better performance.

Our Contributions

We propose a data-driven approach to enhance the blurry images. The key features can be summarized as:

- Our approach is an end-to-end model which can be applied on retinal images without prior knowledge.
- The model is easily to be trained with no paired data required.
- The proposed feature restriction is essential for reliable enhancement of core information.

Pipeline of Our Approach

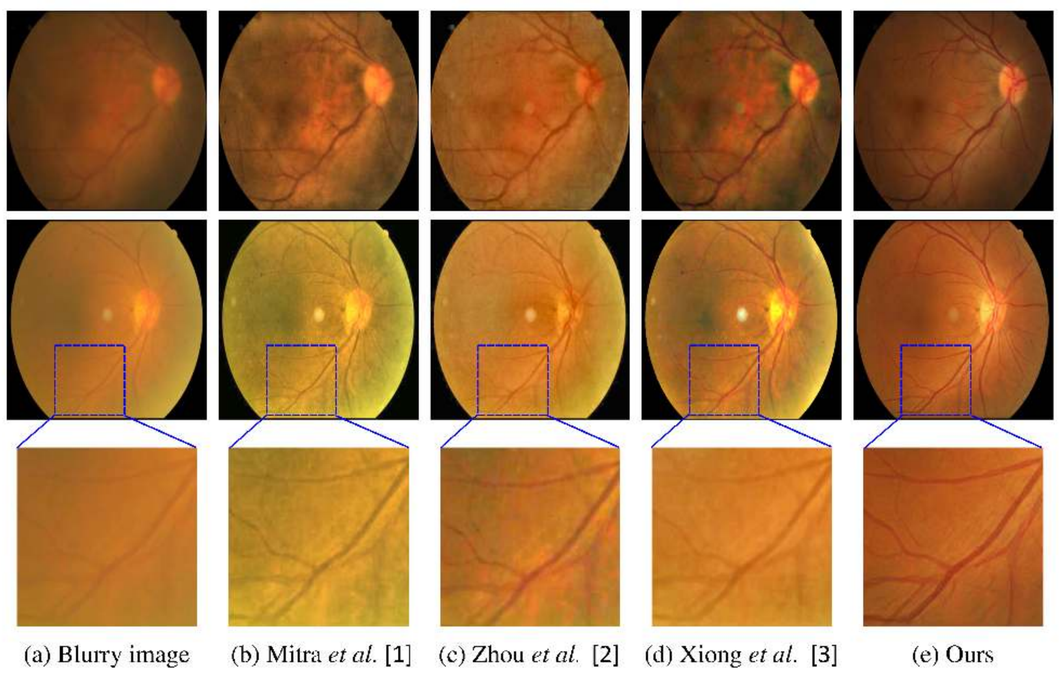


$$\mathcal{L}_{idt} = \|G_e(y) - y\|_1 + \|G_b(x) - x\|_1$$

$$\mathcal{L}_{adv} = (D_e(y) - 1)^2 + D_e(G_e(x))^2 + (D_b(x) - 1)^2 + D_b(G_b(y))^2$$

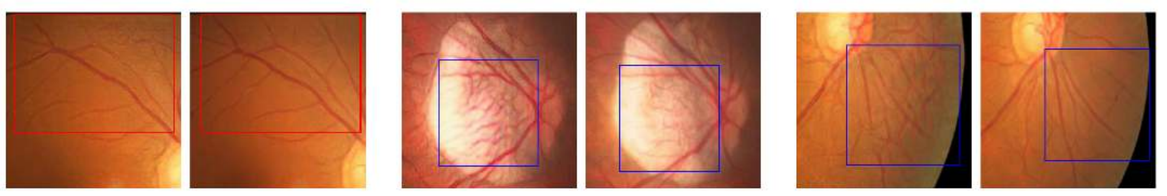
$$\mathcal{L}_{Cfea} = \left\|F^l(G_b(\hat{y})) - F^l(x)\right\|_1 + \left\|F^l(G_e(\hat{x})) - F^l(y)\right\|_1$$

Visual Results of Enhanced images



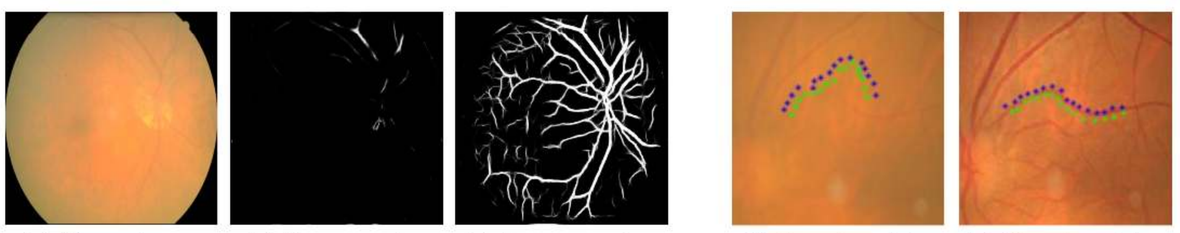
(a) Blurry image (b) Mitra *et al.* [1] (c) Zhou *et al.* [2] (d) Xiong *et al.* [3] (e) Ours

Image Constraint *vs* Feature Constraint



Left: enhanced results with image constraint; **Right**: enhanced results with feature constraint

Vessel Segmentation and Tracing Results Based on Our Approach



(a) Blurry image (b) Segmentation on blury image (c) Segmenetation on enhanced image by ours (d) Vessel tracking on blury image (e) Vessel tracking on enhanced image by ours

Quantitative Results

	No-reference			Full-reference	
	BRISQUE	NIQE	Entropy	PSNR	SSIM
Mitra *et al.* [1]	45.16	3.32	6.69	16.38	0.78
Zhou *et al.* [2]	46.13	4.30	6.74	17.73	0.73
Xiong *et al.* [3]	43.61	3.87	6.67	17.26	0.87
Ours w/o feature constraint	41.39	2.78	6.67	19.03	0.88
Ours	**40.62**	**2.74**	**6.89**	**19.24**	**0.89**

** BRISQUE / NIQE: the lower the better; Entropy / PSNR / SSIM: the higher the better

Conclusion and Outlook

- A data-driven approach is proposed to improve blurry images via Cycle-GAN without paired training data.
- The enhanced processing is helpful for both clinical applications and automatic processing algorithms.
- Using other landmarks as supervision to improve the performance.

References

[1] Mitra, A., Roy, S., Roy, S., Setua, S.K.: Enhancement and restoration of non- uniform illuminated fundus image of retina obtained through thin layer of cataract. Comput. Methods Program. Biomed. 156, 169–178 (2018)
[2] Zhou, M., Jin, K., Wang, S., Ye, J., Qian, D.: Color retinal image enhancement based on luminosity and contrast adjustment. IEEE Trans. Biomed. Eng. 65(3), 521–527 (2018)
[3] Xiong, L., Li, H., Xu, L.: An enhancement method for color retinal images based on image formation model. Comput. Methods Program. Biomed. 143, 137–150 (2017)