International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Modeling and Enhancing Low-Quality Retinal Fundus Images

Najeema Afrin [1], S.Anusha [2], Sana Rayees [3],B.Karthik [4]

[1]Assistant Professor, CMR Technical Campus,
[2,3,4]CMR Technical Campus
Kanlakoya(V),Medchal , Hyderabad, India

****

ABSTRACT

Retinal fundus images are widely used for the clinical screening and diagnosis of eye diseases. However, fundus images captured by operators with various levels of experience have a large variation in quality. Low-quality fundus images increase uncertainty in clinical observation and lead to the risk of misdiagnosis. However, due to the special optical beam of fundus imaging and structure of the retina, natural image enhancement methods cannot be utilized directly to address this. In this article, we first analyze the ophthalmoscope imaging system and simulate a reliable degradation of major inferior-quality factors, including uneven illumination, image blurring, and artifacts. Then, based on the degradation model, a clinically oriented fundus enhancement network (cofe-Net) is proposed to suppress global degradation factors, while simultaneously preserving anatomical retinal structures and pathological characteristics for clinical observation and analysis. Experiments on both synthetic and real images demonstrate that our algorithm effectively corrects low-quality fundus images without losing retinal details. Moreover, we also show that the fundus correction method can benefit medical image analysis applications, e.g., retinal vessel segmentation and optic disc/cup detection.

INTRODUCTION

Clinical image collection in a complex environment using an ophthalmoscope often encounters several types of interference, introduced in the optical feed-forward system. Due to the interspace between the eye and camera, stray light may enter into the ophthalmoscope, mix with the lighting source and result in uneven exposure. This also affects the tuning setting of the programmed exposure, causing global over-/under-exposure. In addition, image blurring caused by human factors (such as eyeball movement, fluttering, and defocus) results in low-quality images.

Recently, general image enhancement methods have achieved state-of-the-art performances, especially with the development of deep learning techniques. However, different from general images, retinal fundus images are acquired through a special ophthalmoscope imaging process to capture anatomical retinal structure for clinical diagnosis, which introduces various additional challenges. First, the retina cannot be illuminated internally; both the incident and reflected imaging beams have to traverse the pupil. Moreover, the spherical geometry of the eye creates significant inter-reflection, resulting in shading artifacts.To ascertain the impact of the Health Technology Board for Scotland's grading model on referrals to ophthalmology services. An analysis was performed of the screening outcomes of 5575 consecutive patients, who were screened by the Grampian Diabetic Retinopathy Screening Program between March and September 2003 according to the recommendations of the Health Technology Board and the Scottish Diabetic Retinopathy Grading Scheme 2003. 3066 (55%) were male. The median age was 65 years. 5.4% were passed on to the level 3 grader and 3.4% were finally referred to ophthalmology services. 2.3% required re-screening in 6 months; 85% were screened without mydriasis; 11.9% had un gradable images despite a staged mydriasis protocol. Time to complete grading was 32 days (22-45). The impact of the Health Technology Board for Scotland's recommendations on referrals to ophthalmology services is modest and should be containable within existing resources.

LITERATURE SURVEY

A. Retinal imaging and image analysis

Many important eye diseases as well as systemic diseases manifest themselves in the retina. While a number of other anatomical structures contribute to the process of vision, this review focuses on retinal imaging and image analysis. Following a brief overview of the most prevalent causes of blindness in the industrialized world that includes age-related macular degeneration, diabetic retinopathy, and glaucoma, the review is devoted to retinal imaging and image analysis methods and their clinical implications. Methods for 2-D fundus imaging and techniques for 3- D optical coherence tomography (OCT) imaging are reviewed. Special attention is given to quantitative techniques for analysis of fundus photographs with a focus on clinically relevant assessment of retinal vasculature, identification of retinal lesions, assessment of optic nerve head (ONH) shape, building retinal atlases, and to automated methods for population screening for retinal diseases. A separate section is devoted to 3-D analysis of OCT images, describing methods for segmentation and analysis of retinal layers, retinal vasculature, and 2-D/3-D detection of symptomatic exudate-associated derangements, as well as to OCT-based analysis of ONH morphology and shape. Throughout the paper, aspects of image acquisition, image analysis, and clinical relevance are treated together considering their mutually interlinked relationships.

B. Restoration of retinal images obtained through cataracts

An optical model for imaging the retina through cataracts has been developed. The images are treated as sample functions of stochastic processes. On the basis of the model a homomorphic Weiner filter can be designed that will optimally restore the cataractous image (in the mean-square-error sense). The design of the filter requires a priori knowledge of the statistics of either the cataract transmittance function or the non cataractous image. The cataract transmittance function, assumed to be low pass in nature, can be estimated from the cataractous image of the retina. The statistics of the non cataractous image can be estimated using an old, pre cataractous photograph of the same retina, which is frequently available. Various modes of this restoration concept were applied to clinical photographs and found to be effective. The best results were obtained with short-space enhancement using averaged short-space estimates of the spectra of the two images.

PROPOSED SYSTEM

In this article, we first analyze the ophthalmoscope imaging system and simulate a reliable degradation of major inferior-quality factors, including uneven illumination, image blurring, and artifacts. Then, based on the degradation model, a clinically oriented fundus enhancement network (cofe-Net) is proposed to suppress global degradation factors, while simultaneously preserving anatomical retinal structures and pathological characteristics for clinical observation and analysis. Experiments on both synthetic and real images demonstrate that our algorithm effectively corrects low- quality fundus images without losing retinal details. we also show that the fundus correction method can benefit medical image analysis applications, e.g., retinal vessel segmentation and optic disc/cup detection.

Based on the human perception mechanism, the proposed network with additional error metrics for perceiving artifacts, is able to correct fundus images with more accurate structures and suppress local defects. An example of a fundus image corrected by our method is shown. The main contributions of this article are summarized as follows:

METHODOLOGY

A. System Architecture

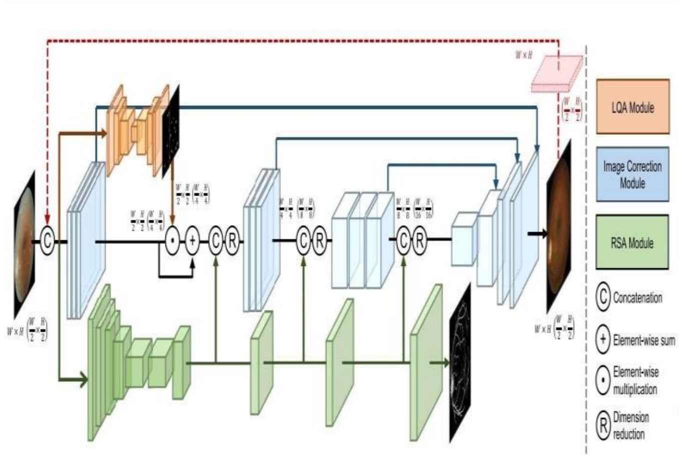


Fig 1: BLOCK DIAGRAM

Based on the human perception mechanism, the proposed network with additional error metrics for perceiving artifacts, is able to correct fundus images with more accurate structures and suppress local defects. An example of a fundus image corrected by our method is shown.The main contributions of this article are summarized as follows:

1) A fundus degradation model based on the retinal ophthalmoscope imaging system is designed to simulate low- quality fundus images. It can be widely utilized to support the typical propagation scheme in fundus image generation models. To the best of our knowledge, this is the first work to model the optical ophthalmoscope. All degradation models are

OUTPUT

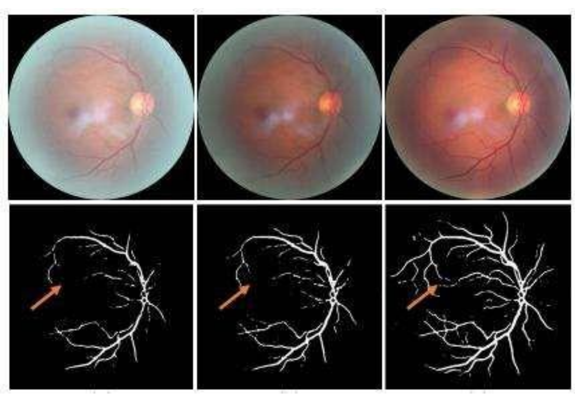


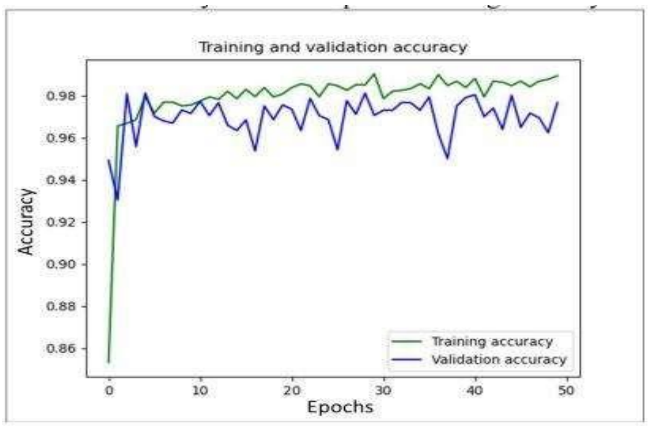
Illustration of fundus image correction

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

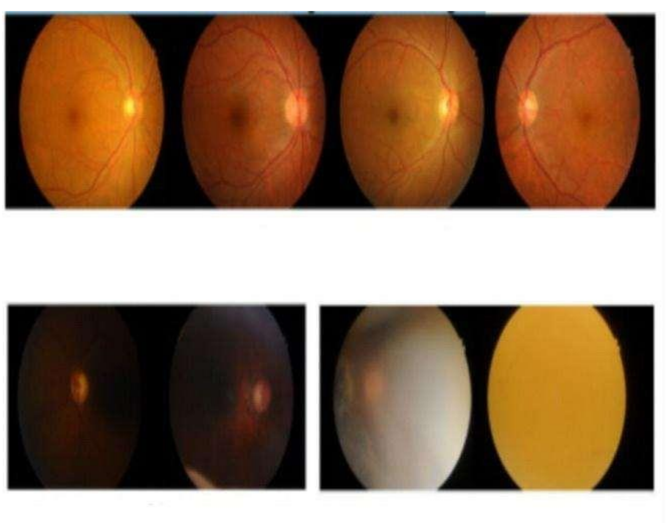
designed based on several imaging stages.

2) A novel clinically oriented fundus enhancement network (cofe-Net) is developed to correct low-quality fundus images for clinical observation and analysis. Our cofe-Net preserves the anatomical retinal structures of fundus image using the RSA module and suppresses undesired artifacts with the LQA module.

3) We show that fundus correction can boost the performances of clinical analysis tasks, e.g., vessel segmentation and disc/cup detection, on poor-quality images. Experimental results on both synthetic and real fundus images demonstrate that our algorithm performs favorably against state-of-the-art approaches.



accuracy and error curves



Example of good images predicted by the proposed method

CONCLUSION AND FUTURE ENHANCEMENT

In this article, we have proposed a clinically oriented fundus enhancement network, named cofe-Net, to correct low-quality fundus image while preserving accurate lesion areas and retinal structures. Furthermore, a complete degradation model has also been introduced to generate adequate training image pairs. Experiments support our insight into the problems of fundus image correction and degradation factor modeling. Our cofeNet can boost the performance for different clinical tasks, such as vessel segmentation and disc/cup detection.

Our method can also assist ophthalmologists in ocular disease diagnosis through retinal fundus image observation and analysis, while also being beneficial to automated image analysis systems.

REFERENCES

[1] M. D. Abràmoff, M. K. Garvin, and M. Sonka, "Retinal imaging and image analysis," IEEE Rev. Biomed. Eng., vol. 3, pp. 169–208, Dec. 2010.

[2] U. Schmidt-Erfurth, A. Sadeghipour, B. S. Gerendas, S. M. Waldstein, and H. Bogunovi´c, "Artificial intelligence in retina," Prog. Retinal Eye Res., vol. 67, pp. 1–29, Nov. 2018.

[3] S. Philip, "The impact of the health technology board for Scotland's grading model on referrals to ophthalmology services," Brit. J. Ophthalmol., vol. 89, no. 7, pp. 891–896, Jul. 2005.

[4] E. Peli and T. Peli, "Restoration of retinal images obtained through cataracts," IEEE Trans. Med. Imag., vol. 8, no. 4, pp. 401–406, 1989.

[5] H. Fu et al., "Evaluation of retinal image quality assessment networks in different color-spaces," in Proc. MICCAI, 2019, pp. 48–56.

[6] Y. Cheng et al., "Adversarial exposure attack on diabetic retinopathy imagery," 2020, arXiv:2009.09231. [Online]. Available: http://arxiv.org/abs/2009.09231

[7] Z. Gu et al., "CE-net: Context encoder network for 2D medical image segmentation," IEEE Trans. Med. Imag., vol. 38, no. 10, pp. 2281–2292, Oct. 2019.

[8] G. Eilertsen, J. Kronander, G. Denes, R. K. Mantiuk, and J. Unger, "HDR image reconstruction from a single exposure using deep CNNS," ACM Trans. Graph., vol. 36, no. 6, p. 178, 2017.

[9] X. Yang, K. Xu, Y. Song, Q. Zhang, X. Wei, and R. W. H. Lau, "Image correction via deep reciprocating HDR transformation," in Proc. IEEE/CVF Conf. Comput. Vis. Pattern Recognit., Jun. 2018, pp. 1798–1807.