Optic Disk And Retinal Vesssel Segmentation In Fundus Images

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Abstract - *Mechanized analysis of retinal descriptions is a challenging research area that aims to provide mechanical methods to help in the early exposure and diagnosis of many eye diseases such as diabetic retinopathy and age related macular disintegration. Retinal image analysis is more and more prominent as a nonintrusive diagnosis method in modern ophthalmology. Thus an algorithm for vessel removal in retinal images is presented in this project. The first step consists of applying anisotropic dissemination filtering in the initial vessel network in order to renovate disconnected vessel lines and eliminate noisy lines. In the second step, a filter procedure allows detecting all vessels having similar proportions at a chosen scale. This algorithm is accompanied by Gabor filter to achieve further exactness. The optic disk disjuncture is performed using two methods, bilateral filter based smoothing and tint object disjuncture. The active method addresses one of the main issues in medical demonstration analysis, "the overlap tissue disjuncture." Since the blood vessel blether into the optic disk area and misguide the graph cut algorithm through a short path, breaking the optic disk boundary, to achieve good disjuncture grades, the MRF image renovation algorithm eliminate vessel in the optic disk area without any transfer of the image structures before sub dividing the optic disk. On the other hand, the compensation factor incorporates vessel using local concentration characteristics to perform the optic disk disjuncture.*

***Key Words*: Automatic disjuncture, binary image, MRF image.**

1. Introduction

The disjuncture of retinal image structures has been of great awareness because it could be used as a nonintrusive diagnosis in up to date ophthalmology. The morphology of the retinal blood vessel and the optic disk is an important structural pointer for assessing the existence and sternness of retinal diseases such as diabetic retinopathy, high blood pressure, glaucoma, haemorrhages, vein closure, and neo vascularisation. However, to assess the thickness and tortuosity of the retinal blood vessel or the shape of the optic disk, physical altimetry has commonly been used by ophthalmologists, which is generally time intense and flat to human error, especially when the vessel structures are convoluted or a large number of images are acquired to be labeled by hand. Therefore, a unfailing mechanized method for retinal blood vessel and optic disk disjuncture, attractive in computer-aided diagnosis.

An mechanized disjuncture and going over of retinal blood vessel features such as diameter, color, and tortuosity as well as the optic disk morphology allows ophthalmologists and eye care specialists to perform mass vision screening exams for early detection of retinal diseases and treatment assessment. This could prevent and reduce image impairments, time interconnected diseases, and many cardiovascular diseases, as well as reduce the cost of the screening.

Over the past few years, several disjuncture techniques have been employed for the disjuncture of retinal structures such as blood vessels and optic disks and diseases like lesions in fundus retinal images. However, the gaining of fundus retinal images under different conditions of elucidation, declaration and field of view (FOV), and the overlap tissue in the retina cause a significant humiliation of the performance of automated blood vessels and optic disk disjuncture. Thus, there is a need for a reliable technique for retinal vascular tree removal and optic disk exposure, which preserves various vessel and optic disk shapes. In the following subdivision, we briefly review the previous studies on the blood vessel disjuncture and optic disk disjuncture separately.

2. Blood Vessel disjuncture

Blood vessels can be seen as thin stretched out structures in the retina, with variation in thickness and length. In order to subdivision the blood vessel from the fundus retinal image, we have implemented a preprocessing technique, which consists of an effective adaptive histogram equalization and tough distance transform. This operation improves the toughness and the exactness of the graph cut algorithm. Fig. 1 shows the illustration of the vessel disjuncture algorithm.

A. Preprocessing

We apply a contrast enhancement process to the green channel image similar to the work presented in [20]. The intensity of the image is inverted, and the illumination is

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 08 | Aug -2017 www.irjet.net p-ISSN: 2395-0072

equalized. The follow-on image is improved using an adaptive histogram equalizer given by

$$I_{\text{Enhanced}} = \left(\sum_{p' \in R(p)} \frac{s\left(I\left(p\right) - I\left(p'\right)\right)}{h^2} \right)^r \cdot M$$

Where I is the green channel of the fundus retinal color image, p denotes a pixel, and $p\_$ is the neighborhood pixel around p. $p\_ \in R(p)$ is the square window neighborhood with length h. $s(d) = 1$ if $d > 0$, and $s(d) = 0$ otherwise with $d = s\,(I\,(p) - I\,(p\_))$. $M = 255$ value of the maximum intensity in the image. r is a parameter to control the level of enhancement. Increasing the value of r would also increase the contrast between vessel pixels and the Bg. The experimental values of the window length was set to $h = 81$ and $r = 6$.

A binary morphological open process is applied to prune the enhanced image, which discards all the misclassified pixels. This approach significantly reduces the false positive, since the enhanced image will be used to construct the graph for disjuncture.

A distance map image is created using the distance transform algorithm. This is used to analyse the path and the magnitude of the vessel gradient. The detachment map of the whole image and a sample vessel with arrows indicating the path of the gradients, respectively. From the sample vessel image, we can see the center line with the brightest pixels, which are progressively reduced in intensity in the direction of the edges (image gradients). The arrows are referred to as vector field, which are used to construct the graph in the next sections.

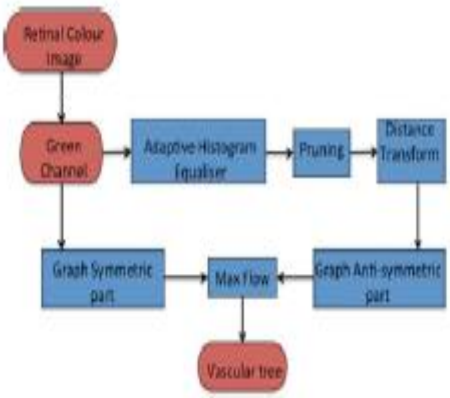

Fig 1. Vessel disjuncture algorithm

3. Optic Disk disjuncture

The optic disk disjuncture starts by defining the location of the optic disk. This progression used the union feature of vessels into the optic disk to estimate its location. The disk area is then sub divided using two different automated methods (MRF image reconstruction and compensation factor). Both methods use the convergence feature of the vessels to identify the position of the disk. The MRF method is applied to eliminate the vessel from the optic disk region. This process is known as image reconstruction and it is performed only on the vessel pixels to avoid the modification of other structures of the image. The renovated image is free of vessels and it is used to sub divide the optic disk via graph cut. In contrast to MRF method, the reimbursement factor approach sub divide the optic disk using prior local intensity knowledge of the vessels. Fig. 2 shows the overview of both the MRF and the reimbursement factor methods.

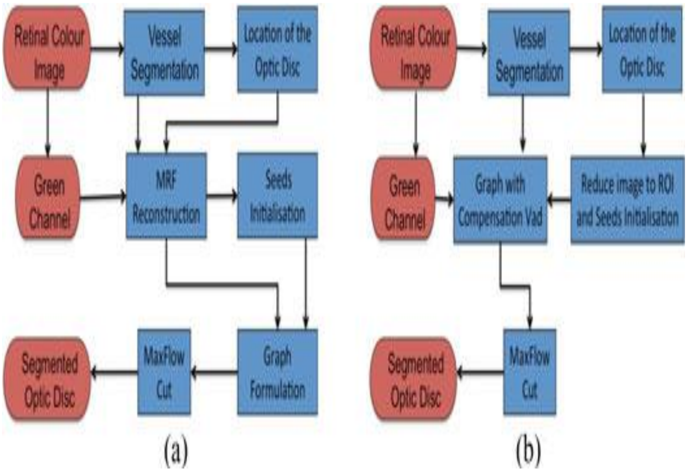

Fig.2. (a) MRF image renovation method diagram and (b) reimbursement factor method diagram.

A. Optic Disk Location

Inspired by the method proposed in [14], which effectively locates the optic disk using the vessels, we use the binary image of vessels segmented in Section III to find the location of the optic disk. The process iteratively traces toward the centroid of the optic disk. The vessel image is pruned using a morphological open process to eliminate thin vessels and keep the main arcade. The centroid of the arcade is calculated using the following
Formulation:

$$C_x = \sum_{i=1}^{K} \frac{x_i}{K} \qquad C_y = \sum_{i=1}^{K} \frac{y_i}{K}$$

where x_i and y_i are the coordinates of the pixel in the binary image and K is the number of pixels set to 1 (pixels marked as blood vessels) in the binary image. Given the gray scale intensity of a retinal image, we select 1% of the brightest region. The algorithm detects the brightest region with the most number of pixels to determine the location of the optic disk with respect to the centroid point (right, left, up, or down). The algorithm adjusts the centroid point iteratively until it reaches the vessel convergence point or the center of the main arcade (center of the optic disk) by reducing the distance from one centroid point to next one in the direction of the brightest region, and correcting the central position inside the arcade accordingly. Fig. 8 shows the process of estimating the location of the optic disk in a retinal image. It is important to notice that the vessel convergence point must be detected accurately, since this point is used to automatically mark Fg seeds. A point on the border of the optic disk may result in some false Fg seeds. After the detection of the vessel convergence point, the image constrained a region of interest (ROI) including the whole area of the optic disk to minimize the processing time. This ROI is set to a square of 200 × 200 pixels concentric with the detected optic disk center. Then, an automatic initialization of seeds (Fg and Bg) for the graph is performed. A neighborhood of 20 pixels of radius around the center of the optic disk area is marked as the Fg pixels, and a band of pixels around the perimeter of the image are selected.

B. Optic Disk disjuncture with MRF Image Renovation

The high contrast of blood vessels inside the optic disk presented the main difficulty for its disjuncture as it misguides the disjuncture through a short path, breaking the continuity of the optic disk boundary. To address this problem, the MRF based renovated method presented in [25] is adapted in our study.We have selected this approach because of its toughness. The objective of our algorithm is to find a best match for some missing pixels in the image; however, one of the weaknesses of the MRF-based renovation is the requirement of intensive calculation. To overcome this problem, we have limited the renovation to the ROI, and using prior sub divided retina vascular tree, the renovation was performed in the ROI. An overview diagram of the optic disk disjuncture with the MRF image renovation is shown in Fig. 2.

4. Results

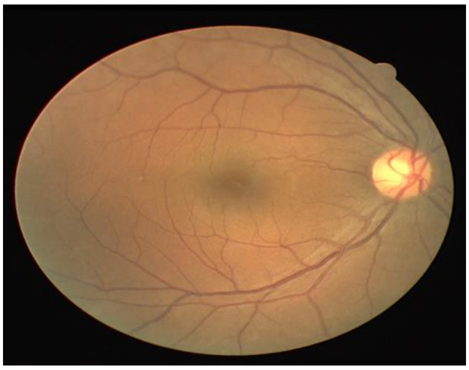

Fig 3. Input fundus image

Fig 4. Green Plane of the input image

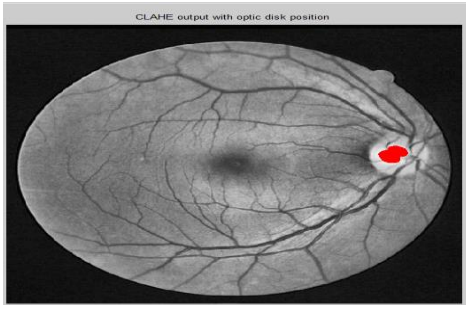

Fig 5.CLAHE output with optic disc position

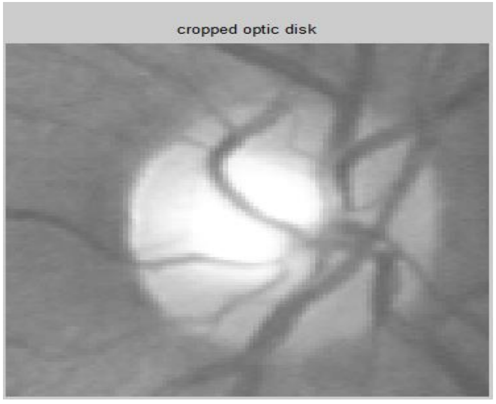

Fig.6.Cropped optic disk

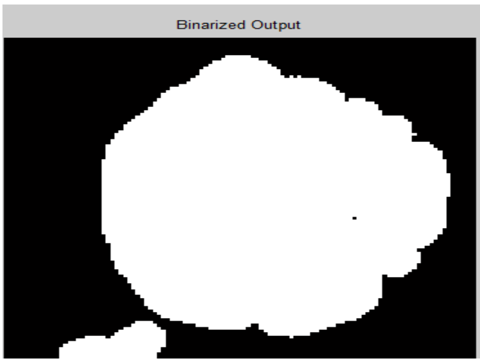

Fig.7. Binarized Output

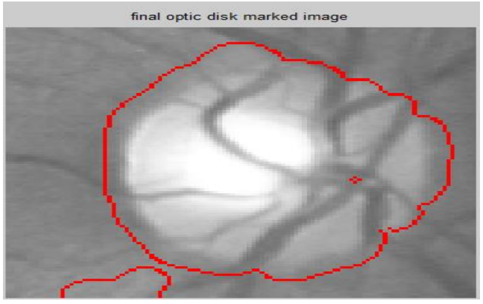

Fig.8.Final optic disk marked image

5. Conclusions & Future Enhancement

We have presented a novel approach for blood vessels and optic disk disjuncture in retinal images by integrating the mechanism of flux, MRF image reconstruction, and reimbursement factor into the graph cut method. The process also involves contrast enhancement, adaptive histogram equalization, binary opening, and distance transform for preprocessing. We have evaluated the performance of vessel disjuncture against ten other methods including human manual labelling. For the optic disk disjuncture, we have evaluated the performance of our method.

Our proposed method incorporates the prior knowledge of blood vessels to perform the disjuncture, and it can be applied on retinal images from multiple sources and under different conditions without a need for training.

Furthermore, the projected methods address one of the main issues in medical image analysis, “the overlap tissue disjuncture.” Since the blood vessels converse into the optic disk area and misguide the graph cut algorithm through a short path, breaking the optic disk boundary, to achieve good disjuncture results, the MRF image renovation algorithm eliminates vessels in the optic disk area without any modification of the image structures before sub dividing the optic disk. On the other hand, the reimbursement factor incorporates vessels using local intensity characteristics to perform the optic disk disjuncture. Thus, our method can be applied in other medical image analysis applications to overcome “the overlapping tissue disjuncture.” Our potential investigate will be based on the disjuncture of retinal diseases (lesions) known as “exudates” using the sub divided structures of the retina (blood vessels and optic disk). Thus, a Bg template can be created using these structures. Then, this template can be used to perform the recognition of suspicious areas (lesions) in the retinal images.

REFERENCES

[1] Reza, A.W. Eswaran, C., and Hati, S. Diabetic retinopathy: “A quadtree based blood vessel algorithm using RGB components in fundus images”, J. Medical Systems, vol 32, pp 147-155, 2008.

[2] K. Jeyasri, P. Subathra, and K. Annaram, “Detection of blood vessels for disease diagnosis”, International Journal of Advanced Research in Computer Science and Engineering”, vol 13, pp 6 – 11, 2013.

[3] A. W. Reza, C. Eswaran, K. Dimyati, “Diagnosis of Diabetic Retinopathy: Automatic Extraction of Optic Disc and Exudates from Retinal Images using Marker-controlled Watershed Transformation”, J Medical System, vol 35, pp 1491 – 1501, 2011.

[4] A. M. Mendonca, A. Campilho, “Segmentation of retinal blood vessels by combining the detection of centrelines and morphological construction”, IEEE Transactions on Medical Imaging, vol 25, pp 1200 – 1213, 2006.

[5] Ahmed. H. Asad, A. T. Azar, M. M. M. Fouad, and A. E. Hassanien, “An improved ant colony system for retinal blood vessel segmentation”, Conference on Computer Science and Information Systems, pp 199 – 205, 2013.

[6] D. Marin, A. Aquino, M. E. Gegundez –Arias, J.M Bravo, “A new supervised method for blood vessel segmentation in retinal images by using gray level and moment invariants based features”, IEEE Transactions on Medical Imaging, vol 30, pp 146 – 158, 2011.

[7] G. B. Kande, P. V. Subbaih, and T. Satya Savithri, “Segmentation of exudates and optic disc in retinal images”, 6th Indian Conference on Computer Vision, Graphics and Image Processing”, pp 535 – 540, 2008.

[8] D. Welfer, J. Scharcanski, D. Ruschel Marinho, “A coarse to fine stradegy for automatically detecting exudates in colour eye fundus images”, Computerized Medical Imaging and Graphics, vol 34, pp 228 - 235, 2010.

[9] A.W. Reza, C. Eswaran, S. Hati, “Automatic tracing of optic disc and exudates from color fundus images using fixed and variable thresholds”, J. Medical Systems, vol 33, pp 73- 80, 2009.

[10] Akara Sopharak, B. Uyyanonvarsa, S. Barman, T. H. Williamson, “Automatic Detection of diabetic retinopathy exudates from non-dilated retinal images using mathematical morphology methods”, Computerized Medical Imaging and Graphics on ELSEVIER, vol 32, pp 720 – 727, 2008.

[11] T. Walter, J. C Klein, P. Massin, and A. Erginay, “A contribution of image processing to the diagnosis of diabetic retinopathy – Detection of Exudates in Color Fundus Images of the Human Retina”, IEEE Transactions on Medical Imaging, vol 21, pp 1236 – 1241, 2002.

[12] Mahendran Gandhi, and R. Dhanasekaran, “Diagnosis of diabetic retinopathy using morphological process and svm

classifier", International Conference on communication and signal processing", pp 873 - 877, 2013.

[13] Eman M. Sahin, Taha E. Taha, W. Al- Nuiamy, S. El Rabaie, Osama F. Zahran, and Fathi E. Abd El- Samie, " Automated detection of diabetic retinopathy in blurred digital fundus images", IEEE Transactions on Medical Imaging , pp 20-25, 2012.

[14] S. Ravishankar, A. Jain, and A. Mittal, "Automated feature extraction of early detection of diabetic retinopathy in fundus images", International Conference in IEEE, pp 210- 220, 2009.

[15] M. G. Fakhtar Eadgahi, H. Pourreza, "Localization of Hard Exudates in Retinal Fundus Image by Mathematical Morphological Methods", International Conference on Computer and Knowledge Engineering, pp 185 – 189, 2012.

[16] K. Noronha, J. Nayak, S. N. Bhatt, "Enhancement of retinal fundus image to highlight the features for detection of abnormal eyes", 10th Conference in IEEE, pp 1- 4, 2006.

[17] M. M. Fraz, S. A. Barman, P. Remagnino, A. Hoppe, A. Basit, B. Uyyanonvara, A. R. Rudnicka, C. G. Owen, "An approach to localize the retinal blood vessels using bit planes and centreline detection", Computer Methods and Programs in Biomedicine, pp 1 – 17, 2011.

[18] M. Z. Che Azemin, D. K Kumar, T. Y. Wong, R. Kawasaki, P. Mitchell, and J. J Wang, " Robust methodology for fractal analysis of the retinal vasculature", IEEE Transactions on Medical Imaging, vol 30, pp 247 – 250, 2011.

[19] A. A. H. A. R. Youssif, A. Z. Ghalwash, and A. A. S. A. R. Ghoneim," Optic disc detection from normalized fundus images by means of a vessels direction matched filter", IEEE Transactions on Medical Imaging, vol 27, pp 11 – 18, 2008

[20] A. S. Gonzalez, D. Kaba, Y. Li and X. Liu, "Segmentation of blood vessels and optic disc in retinal images", DOI 10. 1109 / JBHI .2014. 2302749, IEEE Journal of Bomedical and Health Informatics, pp 1-14.