Cup Disc Along With Blood Vessel And Optic Nerve Segmentation Using PCA And Morphology Method For Detection Of Glaucoma

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Abstract: Analyzing Retinal Images plays a vital role in the Ophthalmology. In this Paper we have presented a few algorithms in order to segment the Blood Vessel in the Retinal Images, and optic nerve segmentation based on PCA and Morphology Top Operation. The optic nerve contains Cup whose ratio are calculated by CDR measurement and it is used by modern Ophthalmology and optometry to access the progression of Glaucoma.
1. Introduction:

The segmentation of blood vessel in the retinal image and detection of optic disc boundary, have created a great interest because it is used for the diagnosis in modern Ophthalmology.

The Blood vessel structure is an important indicator of retinopathy, Hypertension, hemorrhage, vein occlusion. The optic disc boundary detection are majorly used for checking the presence of Glaucoma.

Glaucoma is a disease present in eye, in which fluid presence within eyes rises. If the rise in fluid is unnoticed the person may lose his vision or even there is a chance of becoming blind. On the eye ball there is a small space called “anterior chamber” where these fluids flows in and out nourishes nearby tissue.

If the person is affected by Glaucoma these fluids does not drain properly and it takes more time for draining. Thus it causes the increasing Cup size in optic nerve. The CDR measurement is done where the size of boundary is detected if the size of boundary is abnormal, then it is clear that optic nerve is affected by glaucoma. Thus the detection of boundary manually called as tedious process. It is a time consuming task and human error may occur especially when the vessel structures are complicated. An automated inspection of segmentation of blood vessel and the optic nerve allows ophthalmologist and eye care specialist to find the eye disease at the earlier stage.

2. Related Work:

The segmentation of blood are carried out by two methods such as Adaptive Local Thresholding [2] and Support Vector Machine [2]. Adaptive local thresholding extracts the large thick blood vessels [2] and support vector machine [2] are used to extract the thin bloods present in the blood vessel. It avoids heavy computation and manual error [2]. The next procedure is done with the help of graph cut method for the segmentation of blood vessel [3], it provides prior knowledge formulation. Optic Disc segmentation are carried out in two methods are as Markov Random Field (MRF)[3] and Compensation Factor [3]. MRF is used to remove the blood vessel from retinal images. This process is called as images reconstruction [3].
2.1. Blood Vessel Segmentation:

The Blood vessel is an elongated structure in the retina images with variations in length and width. In order to extract the structure of blood vessel from the fundus images various algorithms have been applied, thus it includes Pre-Processing, Post-Processing, Optic-disc Segmentation and the evaluations of CDR measurement, to find the presence of Glaucoma in the Optic-Disc. By this methods the Ophthalmologist and eye Specialists use this vessel structure for the primary treatment of any eye diseases, once they found the defects in eye further evolution is carried out.

Figure 1: Optic Disc Segmentation

3. Methodology In Blood Vessel Segment And Optic Nerve:

3.1. Image Acquisition:

Evaluation of our experiment the fundus images are taken by digital camera known as ophthalmoscope. This fundus images is an interior part of an eye which capture the surface structure of Retina, Macula and the posterior pole.
3.2. Principle Component Analysis:

Used for an image compression of Retina Blood vessel. Even though many algorithms are used but those are resulted in loss in image color reduction. This PCA algorithm is used for data demission and decorations. Thus the Fundus images are converted into Red component image, Blue Component image, and Green component image, and single component are extracted which contains major part of information. For further experimental we are going to take Green Component which is a useful major information.

3.3. Adaptive Histogram Equalization:

Adaptive Histogram Equalization has tendency to over amplify noise generated in the images, thus it increase the contrast of an images. AHE amplifies the images by pixel values, The Brightness of near Pixel are taken to improve the brightness in poor region. This divides the images into small blocks called “tiles”. Then each of these blocks are histogram Equalized as usual, so the smaller area histogram would confine to a small region. In case of presence of any noise it is amplified.
3.4. Exemplar-Based In-painting:

Exemplar-Based In-painting is an efficient approach for reconstructing large target region. This approach iteratively synthesizes the target region by most similar patch in the source region. These overcome the drawbacks of PDE which produce some blur and become noticeable when filing larger region. Thus above extracted Contrast increased image which is obtain in Adaptive Histogram equalization contains some missing information, this missing information causes difficulty in detection of eye diseases. To overcome this Exemplar-Based In painting is used where Missing information are extracted from the nearby pixel area which is closely related with this information. At first the missing position is analyzed and then the predefined priority function.

![Image of vessel structure](image)

*Figure 4: (a) Vessel structure Left (b)Vessel structure Right*

3.5. Top-Hat Transformation:

The Top-hat transformation is a one of the morphological technique that is use to extract the “small elements” and the missing information for the blood vessel structure. There two methods of top-hat transformation are carried out, they are white Top-hat transformation and black Top-hat transformation. In this we are going to Black Top-hat transformation which is used to fill the holes of blood vessels.

\[ T_b (f) = f \cdot b - f \]

\( T_b (f) \) - Black top-hat transformation

B-Closing operation and \( f \) is filled image.
4. Optic Disc Segmentation:

4.1. Watershed Algorithm:

Watershed Algorithm uses the modern morphological method, while segmentation of blood vessel structure major issue that occur is Over-segmentaion. As the blood vessel is a minute structure with thin lines thus they are over-segmented with another blood structure. To extract this separately and to determine the optic disc structure watershed algorithm is used in which Erode and Dilation methods carried out. Erode method is used to increase the size of blood structure, where interarel rim ere accuratey determined.

4.2. CDR Measurement:

After the boundary detection of optic nerve, we are going to find the overall diameter of an optic nerve. Thus the disk varies from 0.80mm to 6.00mm. In the optic Nerve the vertical diameter being more than the horizontal diameter. An average value of vertical diameter varies from 1.85mm to 1.95mm and horizontal diameter varies from 1.70mm to 1.80mm. The optic nerve varies from person to person. The value optic Nerve disc are calculated by the formula as given in the following line r/4 *horizontal diameter*vertical diameter Optic cup is an internal rim of optic nerve, where it is presented inside the optical disc. Thus the horizontal and vertical values are calculated. The horizontal diameter value is 0.83mm and the vertical diameter value is 0.77mm. CDR measurement are carried out by dividing the optic disc by optic cup.

CDR= Optic nerve value/ Optic cup
5. **Conclusion:**

In ophthalmology the blood vessel segmentation and optic disc boundary are detected more accurately by the proposed method. Once the optic disc boundary has been detected, the optic nerve ratio and the optic cup ratio value are calculated very easily to identify the diseases. The CDR measurement is done by dividing the optic nerve to optic cup. Thus the presence of glaucoma can be indentified in early stages and further treatment can be carried out by the ophthalmology.
References:

5. “Retinal Image segmentation by watersheds “published on 2009 by Cristian Perra, Maria Petrou.