RETINAL BLOOD VESSEL SEGMENTATION AND DETECTION USING K-MEANS AND MORPHOLOGICAL CLUSTERING

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Abstract - The Retinal image analysis through efficient detection of vessels and exudates for retinal vasculature disorder analysis. It plays important roles in detection of some diseases such as diabetes, which can be identified by analysis of the retinal blood vessels condition. It consists of two stages.First stage is blood vessel classification approach, which is used for computer based retinal image analysis to extract the retinal image vessels. The second stage is the segmentation part .Mathematical morphology and K-means clustering are used to segment the blood vessels of retina. To enhance the retinal blood vessels and subdue the background information, we perform smoothing operation on the retinal image using mathematical morphology.

Index terms - Retinal images, Segmentation, Mathematical Morphology, K-means clustering.

I. INTRODUCTION

The retina in the eye is the third and inner coat of the eye which is a sensitive layer of light towards tissue. The optics of the eye create an image of the visual world on the retina through the cornea and lens, which acts as the film of a camera. Light falling on the retina induces chemical and electrical reactions that ultimately initiates the nerve impulses. They are forwarded to visual centres of the brain optic nerve. Neural retina typically refers to three layers of neural cells ,photo receptor cells, bipolar cells, and ganglion cells with the retina, while they refers to three layers of pigmented epithelial cells.

Figure1:Retinal Image

Retinal images are influenced by all the factors that affect the body vasculature in general as shown in figure1. The human eye is a unique region of the human body where the vascular condition can be directly observed. In addition to fovea and optic disc, the blood vessels contributes one of the main features of an retinal fundus image and several of its properties are noticeably affected by worldwide major diseases such as diabetes, hypertension, and arteriosclerosis.

II. PROPERTIES OF BLOOD VESSELS

- **a.** The blood vessels usually have small curvature, the anti-parallel pairs may approximated by piecewise linear segments.
- **b.** Vessels have lower reflectance than other retinal surfaces, so they appear darker relative to the background.
- **c.** Vessel size may decrease when moving away from the optic disk, the width of a retina vessel may lie within the range of 2–10 pixels.
- **d.** The intensity profile varies by a small amount from vessel to vessel.
- **e.** The intensity profile has a Gaussian shape.

III. IMAGE SEGMENTATION

Segmentation partitions an image into distinct regions containing each pixels with similar attributes .Image segmentation is the problem of partitioning an image into meaningful parts, often consisting of an object and background. As an important part of many imaging applications, e.g. face recognition, tracking of moving cars and people etc, it is of general interest to design robust and fast segmentation algorithms. In many practical applications, as a large number of images are needed to be handled, human interactions involved in the segmentation process should be as less as possible. This makes automatic image segmentation techniques more appealing.

In region-based methods, a lot of literature has investigated the use of primitive regions as a preprocessing step for image segmentation as shown in figure2. The advantages are twofold. First, regions carry on more information in describing the nature of objects. Second, the number of primitive regions is much fewer than that of pixels in an image and thus largely speeds up the region merging process. Starting from a set of primitive regions, the segmentation is conducted by progressively merging the similar neighboring regions according to a certain predicate, such that a certain homogeneity criterion is satisfied. The edge detection algorithms are based on the abrupt changes in image intensity or color, thus salient edges can be detected. However, due to the resulting edges are often discontinuous or over-detected, they can only provide candidates for the object boundaries. Another classical category of segmentation algorithms is based on the similarities among the pixels within a region, namely region-based algorithms. In order to cluster the collection of pixels of an image into meaningful groups of regions or objects, the region homogeneity is used as an important segmentation criterion.A good segmentation algorithm should preserve certain global properties according to the perceptual cues. This leads to another essential problem in a region merging algorithm: the order that is followed to perform the region merging. Since the merging process is inherently local, most existing algorithms have difficulties to possess some global optimality.

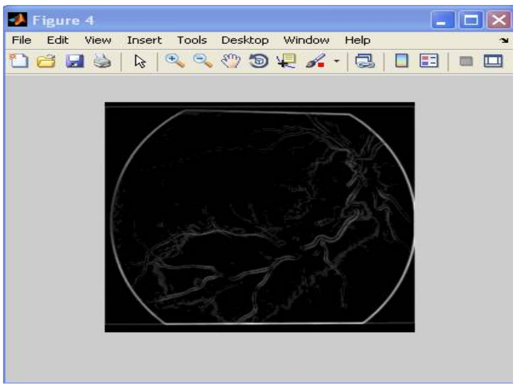
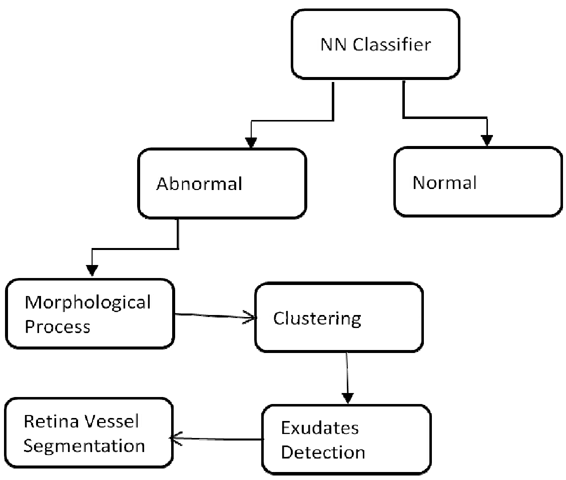


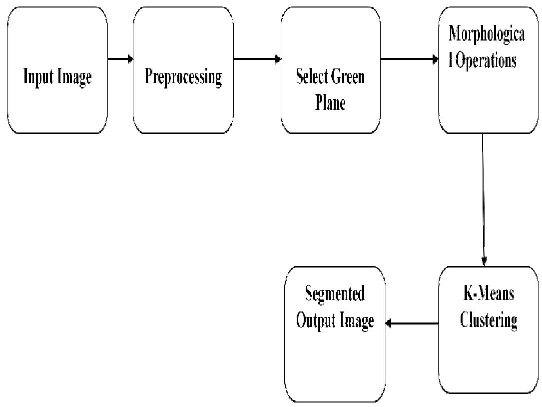
Figure2: Segmented Image

IV. PROPOSED SYSTEM

BLOCK DIAGRAM-I



BLOCK DIAGRAM-II



V. PLANE SEPERATION

The retinal fundus image is divided in to three primary components such as Red Channel (R), Green Channel (G) and Blue Channel (B). The green channel is high sensitive to the blood vessels. Hence this channel is considered for the detection and segmentation of retinal blood vessels from the retinal image. In this method, the color scale RGB images as shown in Figure3 are first converted into grayscale for efficient computation. Since the exudates are visible with more contrast in grayscale an equalization procedure was performed on the images to obtain a local contrast i,e approximately, equal at all image intensities.

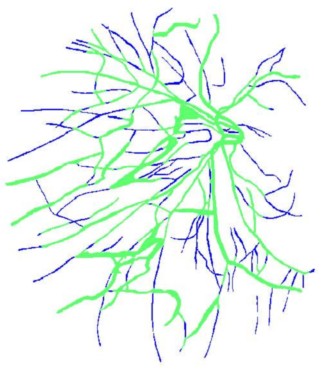


Figure3: Plane Separated Image

$$C(x, y) = f(x, y) - \text{median}(x, y)$$

Where C (x, y) is the estimated local contrast, f (x, y) is the image gray level at (x, y), median (x, y) is the median gray level within the neighborhood of (x, y).This can be equated to a high pass spatial filter. The local contrast provides a measure of the high-frequency image noise.

VI. MORPHOLOGICAL PROCESS

Morphological operations are applied to the input image for smoothening and optic disk detection. It processes the image based on shapes and it performs on image using structuring element.The morphological opening and closing operation are applied to an image based on multi structure elements to enhance the vessel edges. Dilation and erosion process will be used to enhance smoothening of the optic disc region by removing the unwanted pixels from outside region of exudates part. These morphological operations are performed on images based on shapes.It is formed by structuring element. It is a matrix containing 1's and 0's where 1's are called neighbourhood pixels.The output pixel is determined by using these processing pixel neighbours.Here, the 'diamond' structuring element is used to dilate and erode the image for smoothing. It is the process of adding a pixel at object boundary based on structuring element.

VII. KMEANS CLUSTERING ALGORITHM

K-means is one of the simplest unsupervised learning algorithms that solve the well known clustering problem as shown in figure4. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters assume k clusters fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids shoud be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given data set and associate it to the nearest centroid. When no point is pending, the first step is completed and an early groupage is done. At this point we need to re-calculate k new centroids as bary centers of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop has been generated. As a result of this loop we may notice that the k centroids change their location step by step until no more changes are done. In other words centroids do not move any more.Finally, this algorithm aims at minimizing an objective function, in this case a squared error function.

$$J = \sum_{j=1}^{k} \sum_{i=1}^{n} \left\| x_i^{(j)} - c_j \right\|^2$$

where $\left\| x_i^{(j)} - c_j \right\|^2$ is a chosen distance measure between a data point $x_i^{(j)}$ and the cluster centre c_j, is an indicator of the distance of the n data points from their respective cluster centres. Place K points into the space represented by the objects that are being clustered. These points represent initial group centroid. Assign each object to the group that has the closest centroid. When all objects have been assigned, recalculate the positions of the K centroid.Repeat Steps 2 and 3 until the centroid no longer moves.

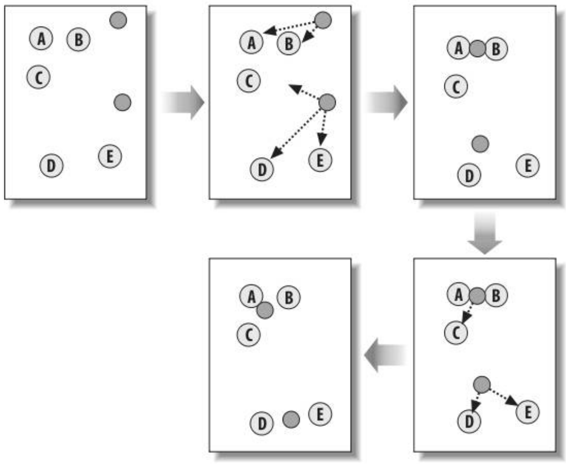


Figure4: K means Cluster

VIII. RESULTS

The figure represents the corresponding output of the images at various stages of segmentation process.

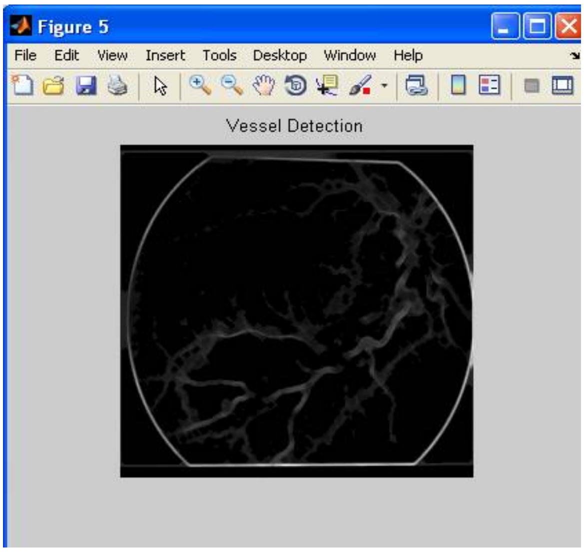


Figure5: Transformed Gray Scale Images After Applying Wavelet Transformand the Vessels Are Detected

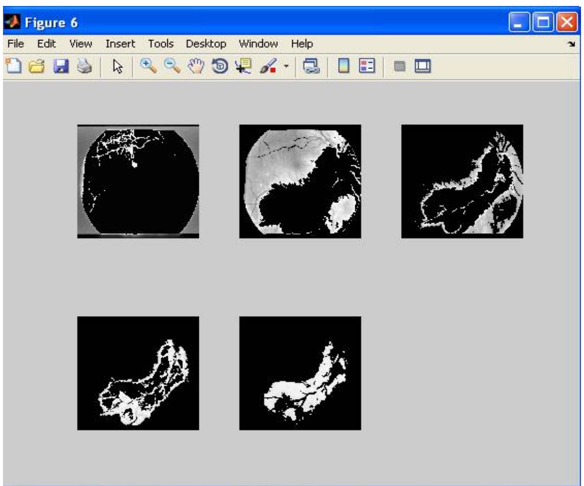


Figure6: After applying k-means clustering algorithm and the final segmented blood vessels are obtained

CONCLUSION

Thus the mathematical morphology is applied as a pre-processing phase with k-means clustering. Mathematical morphology is employed to enhance and smooth the retinal images and to suppress the background information. Then, the k-means clustering is applied to segment the vessels. Hence the blood vessels are detected from the retinal image.

REFERENCES

[1] Pawel liskowski,Krzysztof krawiec,"Segmentating retinal blood vessels with deep neural networks",IEEE Trans.Med.Imag.,2016.

[2] Y. Zhao, L. Rada, K. Chen, S. P. Harding, and Y. Zheng, "Automatedvessel segmentation using infinite perimeter active contour model withhybrid region information with application to retinal images," MedicalImaging, IEEE Transactions on, vol. 34, no. 9, pp. 1797–1807, 2015.

[3] M. Fraz, P. Remagnino, A. Hoppe, B. Uyyanonvara, A. Rudnicka,C. Owen, and S. Barman, "Blood vessel segmentation methodologiesin retinal images - a survey," Comput. Methods Prog. Biomed.,vol. 108, no. 1, pp. 407–433, Oct. 2012.

[4] M. D. Abrmoff,M. K. Garvin, andM. Sonka, "Retinal imaging and image analysis," IEEE Trans. Med. Imag., vol. 3, pp. 169–208, Jan. 2010.

[5] J. V. Soares, J. J. Leandro, R. M. Cesar Jr, H. F. Jelinek, and M. J. Cree,"Retinal vessel segmentation using the 2-d gabor wavelet and supervisedclassification," Medical Imaging, IEEE Transactions on, vol. 25, no. 9,pp. 1214–1222, 2006.

[6] J. Staal, M. D. Abràmoff, M. Niemeijer, M. A. Viergever, and B. vanGinneken, "Ridge-based vessel segmentation in color images of theretina," Medical Imaging, IEEE Transactions on, vol. 23, no. 4, pp.501–509, 2004.

[7] A. Hoover, V. Kouznetsova, and M. Goldbaum, "Locating blood vesselsin retinal images by piecewise threshold probing of a matched filterresponse," Medical Imaging, IEEE Transactions on, vol. 19, no. 3, pp.203–210, 2000.

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