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Segmentation and Detection of Optic Disc Using Kmeans Clustering

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ABSTRACT- Diabetic retinopathy and glaucoma are one of the major cause of blindness. Early stage segmentation and detection of optic disc may be of great help to *ophthalmologist for treatment of patient before any serious complications. In this paper new methodology is proposed for the detection of the optical disk from the retinal images. Input image is first preprocessed using spatial average filtering on the green color band. Then the preprocessed image is divided into clusters using kmeans clustering algorithm. Cluster with maximum intensity is filtered using connected component to segment out the optic disc. Optic disc is detected by comparing the segmented optic disc and the ground truth respectively. The proposed method is tested on four public available data sets, DIARETDB0, DIARETDB1, DRIVE and STARE. This method offers a successful detection of OD which may help in diagnosis of various retinal abnormalities.*

Index Terms - *diabetic retinopathy , optic disc, kmeans clustering.*

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1. INTRODUCTION

Diabetes is a disease in which the body of a person is not able to control the sugar i.e. glucose in the blood. If diabetes is not treated for prolong period time then it leads to Diabetic Retinopathy [DR] which affects microvasculature of the retina [1]. The root cause of blindness and visual loss is DR [1]. It is of two types: non-proliferative and proliferative. Retinopathy affects the shape of the Optic Disc [OD]. OD detection and segmentation helps in identification of retinopathy and glaucoma in earlier stages [2]. Retinal images are required for the detection of the OD. OD is the brightest region with highest gray levels and is approximately circular in shape. There are many challenges for the segmentation of OD such as its position varies from one image to other and the blood vessels cause hindrance as the originate from the optic disc [3]. OD segmentation is also helpful to identify the anatomical structures (the retinal blood vessels and the macula) [4] and pathological features (exudates, drusen, micro aneurysms, and hemorrhages) [5]. Early stage segmentation and treatment of DR may be of great help to ophthalmologist for treatment of patient in advance, before any serious complication. In proposed work segmentation is performed using k-mean clustering algorithm, then optic disc is detected on the basis of major and minor axis. Detection is done by comparing the segmented optic disc with ground truth.

This paper is divided into 5 sections as follows: related work is presented in section 2. Section 3 describes the method used in detection for optic disc. Results are calculated in section 4. Finally conclusion is given in section 5.

2. RELATED WORK

Lot of work has been done in optic disc segmentation with different approaches. In [2] authors region growing method for the segmentation of optic disk and compare their results with thresholding technique. Region growing technique include various steps for the segmentation of optical disk such as preprocessing, extraction of blood vessels, vessel subtraction, image inpainting, region growing and finally the segmented optic disk.

In other approach algorithm was based on active contours for the detection of optical disk and compared their result with truth value taken from ophthalmologist [6] .In this technique extraction and removal of retinal blood vessels is done with the help of morphological operator and the boundary of optical disk is detected using active contour method.

Joshi et al proposed an algorithm for the detection of optic nerve head and macula region based on optic cup location and anatomical structural details from diabetic retinopathy images of both left and right eye [7]. In this technique optical disk and macula is segmented by performing AND operation between threshold image and Canny edge detection and dilated image. Detected optic disc area is validated by comparing it with hand-drawn ground-truth.

Active contours technique based on homogeneity of optical disk region was proposed by Saradhi et al [3]. Active contour model is improved by preprocessing fundus image in the Lab color space. This technique has improved the exactness of boundary but not on the accuracy of optical disk detection.

In [8] authors use Hausdorff symmetry operator for the segmentation of retinal blood vessels. Hausdorff operator is used for the selection of centerline pixel and then region growing is used for segmentation retinal blood vessels. In this technique the image is subpixeled to get higher accuracy. This method can be used in optic disk segmentation.

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3. METHOD

The block diagram of the proposed system, which explains step by step implementation, is shown in Fig. 1. The input retinal images are taken from public available DRIVE, STARE, DIARETDB0, DIARETDB1 databases.

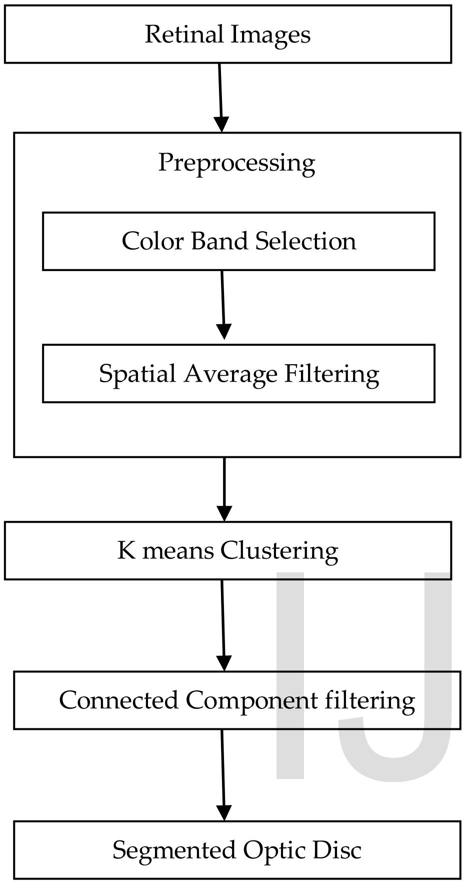

Figure 1: The Block diagram of Proposed algorithm.

3.1. Preprocessing

An image either captured by digital camera or extracted from frames of video sequences needs pre-processing. Video footages or image may contain variation of brightness or color information known as noise. To cope with such degraded images or video frames, images are enhanced which improves visibility and perceptibility of image. The goal of pre-processing includes: removing the noise, enhancing contrast, sharpening or smoothing, elimination or retaining certain features in an image.

The initial step is to separate the color bands from the retinal images. Sample input image and its primary color bands (R,G,B) are shown in in Fig. 2. These different bands own distinct facts about anatomical and pathological structure in the retinal images [1]. OD is the brightest region so, that color band is used in which its intensity is better. The green color band is better for the segmentation of OD as compare to red and blue color band. The red color band image is saturated and in blue color band image is of low intensity. In green color band image is of good contrast, so it is used for further processing.

we used spatial averaging filter to smooth vessel and optical disc of the retinal images. This helps in reliable extraction of optic disc from retinal images. Linear spatial filter of type "disk" of size 10 has been used in our proposed algorithm to remove noise and smoothen the image.

Fig 2(a) Input Retinal Image

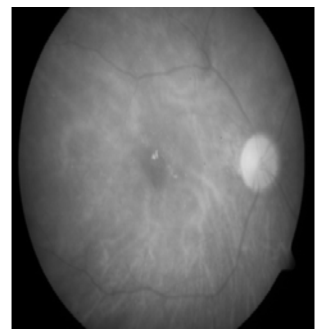

Fig 2(b) Red Color Band Image

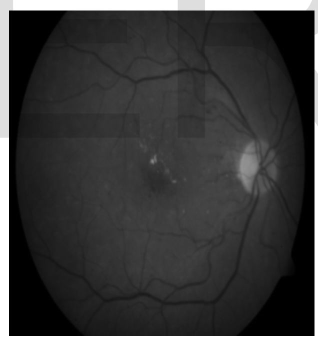

Fig 2(c) Green Color Band Image

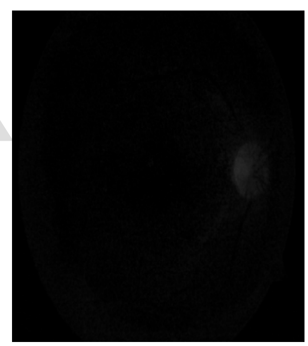

Fig 2(d) Blue Color Band Image

3.2. Segmentation

K-means clustering

k-means clustering is a method partitioning data into *k* mutually exclusive clusters. It returns the index of the cluster to which it has assigned each observation. For large amount of data *k*-means clustering is often more suitable than hierarchical clustering [10]. Each observation in data is treated as an object located in space. Objects which are close to each other lie in one cluster. One cluster may have more than one region according to distribution of objects in the space. Each cluster is described by its centroid and member function. K-means is an iterative algorithm that minimizes the sum of distances from each object to its cluster centroid. Result of k-means is the well-separated and closely-packed clusters as possible. Selection of value of k (number of cluster) is also of great importance as effects the result. In this algorithm k=4 has been used as there are four regions background, foreground, optic disc, blood vessels [9].

Output of k-means is 4 well-separated clusters. As the optic disc is the brightest region, so we select the cluster with the maximum intensity. To segment out the optic disc filtration has to be done to remove unwanted regions. Connected component based filtering is used to remove the unwanted regions and to segment out the optic disc.

Connected Component Analysis (CCA) is a well-known technique in image processing that scans an image and labels its pixels into components based on pixel connectivity. The labelling can be done if pixels are connected with each other (either with four way connectivity or eight way connectivity) or if all pixels share similar intensity values in a connected component. MajorAxisLength and MinorAxisLength parameters are used to select the region. MajorAxisLength and MinorAxisLength are the scalar quantities specifying the length of major axis and minor axis in which the object fits respectively. Approximate values of MajorAxisLength and MinorAxisLength are calculated for the optic disc from the ground truth. MajorAxisLength and MinorAxisLength of different regions are compared to approximate values to filter out the optic disc.

4. EXPERIMENTS AND RESULTS

The proposed methodology was implemented with image processing toolbox in MATLAB® 2013a on a system having Core 2Duo processor (1.67 Ghz) and 2 GB memory. The algorithm is implemented on 302 retinal images. Retinal images are publically available from DRIVE, STARE, DIARETDB0, DIARETDB1 databases. The performance of detection is measured by calculating the centroid of the segmented optic disc and is compared with the boundary of the ground truth, if the centroid lies between the ground truth then the optic disc is said to be detected successfully. Table 1 shows the efficiency of the algorithm in detection of optic disc in various databases. The overall efficiency of the proposed method is 83.4%.

TABLE 1
Detection of Optic Disc in Various Databases

Database	Total images	False detection	True detection	Efficiency
DRIVE	40	2	38	95
STARE	77	22	55	71.4
DIARETDB0	100	8	92	92
DIARETDB1	89	22	67	75.2

5. CONCLUSION

Early stage of diabetic retinopathy may be of great help to ophthalmologist for treatment of patient before any serious complications. This research work is conducted to detect the optic disc in retinal images. The segmentation of is done by using K-means clustering algorithm. The cluster regions having highest intensity is considered as the optic disk and by filtering these given regions on the basis of major and minor axis, optic disc is segmented out. Detection is done by calculating the centroid of the segmented optic disc and by comparing it with the boundary of the ground truth. The performance of the proposed algorithm is satisfactory on the public available of the retinal images. In future the work will be done to improve the detection accuracy of the optic disk and the segmentation of the vascular structure of the retinal images.

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