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SIMPLE AND FAST ALGORITHM FOR DETECTING FOVEA REGION BY THRESHOLDING METHOD

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Abstract - Fovea detection is a significant and effective topic in the field of biomedical and image processing. The fovea is responsible for sharp vision and for seeing fine detail and color in human eyes. The central region called the macula and small depression in the centre of the macula is called fovea. The extraction of fovea region is mainly based on adaptive thresholding method. This image segmentation method isolates objects by converting gray scale images into binary images and effective way of partitioning an image into foreground and background. This method has been implemented in MATLAB and is most effective in images with high level of contrast. .The main advantage is detecting disease at early stages. Proposed method explains various methods like image acquisition pre-processing ,Adaptive histogram ,optic disc detection, blood vessel segmentation and detection of fovea.

Keywords-Optic disc, adaptive histogram,pre-processing, fovea

I. INTRODUCTION

The fovea is an important part of the eye ,it is a small central pit composed of closely packed cones. It is located in the center of the macula lutea of the retina. The fovea is responsible for sharp central vision which is necessary in humans for activities where visual detail is of primary importance and is responsible for clear vision .The fovea is literally a small depression in the retina .A healthy fovea is key for reading, watching television ,driving and other activities that require the ability to see detail .Unlike the peripheral retina, it has no blood vessels .Instead ,it has a very high concentration of cones allowing us to appreciate color. The fovea is surrounded by the parafovea belt ,and the perifovea outer region. The parafovea is the intermediate belt ,where the ganglion cell layer is composed of more than five rows of cells ,as well as the highest density of cones, the perifovea is the outermost region where the ganglion cell layer contains two to four rows of cells ,and is where the visual acuity is below the optimum .The main aim of the fovea detection is to detect eye diseases like diabetic retinopathy at its early stages. A typical retinal fundus image with its features labeled is shown in figure 1.

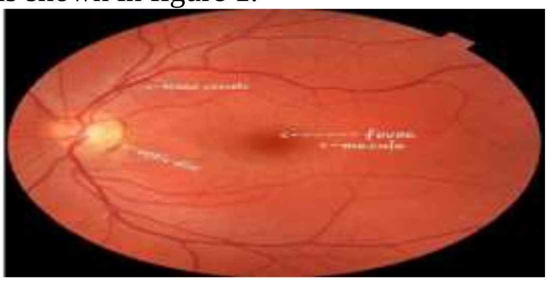

Figure1 : Retinal Fundus Image

Diabetic retinopathy is retinopathy caused by complications of diabetics ,a systemic diseases, which can eventually lead to blindness. It is an ocular manifestation of diabetes ,a systemic disease, which affects up to 80 percent of all patients who have had diabetes for 10 years or more .Each year in the united states, diabetic retinopathy accounts for 12% of all new cases of blindness for people aged 20 to 64 years. Damage to the blood vessels in the retina is the cause of diabetic retinopathy, blood vessels may swell and leak fluid .Diabetic retinopathy can get worse and cause vision loss. Diabetic retinopathy usually affects both eyes.

Adaptive thresholding is used to segment an image by setting all pixels whose intensity values are above a threshold to a foreground value and all the remaining pixels to a background value .Adaptive thresholding is the simplest method of image segmentation., From a grayscale image, thresholding can be used to create binary images. Adaptive thresholding changes the threshold dynamically over the image. This more sophisticated version of thresholding can accommodate changing lighting conditions in the image, e.g. those occurring as a result of a strong illumination gradient or shadows. Adaptive thresholding typically takes a grayscale or color image as input and ,in the simplest implementation ,outputs a binary image representing the segmentation. For each pixel in the image ,a threshold has to be calculated .If the pixel value is below the threshold it is set to the background value, otherwise it assumes the foreground value. The assumption behind the method is that smaller image regions are more likely to have approximately uniform illumination, thus being more suitable for thresholding. Each image can be divided into an array of overlapping sub images and then find the optimum threshold for each sub image by investigating its histogram .The threshold for each single pixel is found by interpolating the results of the sub images .An alternative approach to finding the local threshold is to statistically examine the intensity values of the local neighborhood of each pixel. The statistic which is most appropriate depends largely on the input image. Simple and fast functions include the mean of the local intensity distribution .The mean of the minimum and maximum value ,T=Max +Min/2.The size of the neighborhood has to be large enough to cover sufficient foregroumd and background pixels, otherwise a poor threshold is chosen. On the other hand ,choosing regions which are too large can violate the assumption of approximately uniform illumination .
Arturo Aquino[1] presented a method to detect optic disc with morphological , edge detection and feature extraction techniques. This paper presents a new template-based methodology for segmenting the OD from digital retinal images. This methodology uses morphological and edge detection techniques followed by the Circular Hough Transform to obtain a circular OD boundary approximation. It requires a pixel located within the OD as initial information. For this purpose, a location methodology based on a voting-type algorithm is also proposed. Soumitra Samanta [5] proposed a fast algorithm for detection of fovea. Fovea is one of the important feature of a fundus retinal image. This paper presents a simple and fast algorithm using Mathematical Morphology to find the fovea region. Proposed algorithm is based on the structure of the blood vessels and little bit information of the optic disk. This method is focused on the structure of the blood vessels around the macula region and has used a little bit information of the OD and the blood vessels structure information around the macula region to localize the fovea region further accurately. The proposed algorithm consists of two parts. In first part, we have detected the blood vessels of the retinal fundus image. In the next stage, we have utilized the geometrical distance between OD and fovea region and the structure of the blood vessels to perfectly localize the fovea region. Jeetinder Singh[3] present a method for fovea localization which does not use organization information of other retinal structures like optic disk and arcades. The main advantage of this method is that it does not require segmentation/localization of other retinal structures which are required as prior knowledge in existing fovea localization methods. The key idea is to enhance the relative contrast between the fovea and its surrounding such that it is well-separated in a retinal image. The goal of this paper is first develop a method for fovea localization without prior knowledge of other features. Secondly, the algorithm is analyzed and tested for detection of fovea region. The approximate size of the visible fovea region in a final output

image can also be obtained. It present an algorithm for detecting the fovea which is based on the following domain knowledge: fovea is the darkest region within the macula in a color retinal image with a distinguishing feature namely, the absence of blood vessels . The degree of darkness and size depends on factors such as uneven illumination, presence of lesions such as drusen and exudate's. The proposed algorithm is based on difference of two image planes by modeling the fovea detection as one of signal detection from clutter. The outcome of the proposed detection consists of top two candidates for fovea. An effort has been made to cope with retinal images distorted by the presence of lesions etc. C.Sundhar[2] proposed a method for automatic screening of fundus (retinal) images for detection of diabetic retinopathy using its spatial features and classifying the images using an artificial neural network. Automatic screening will help for the doctors to quickly identify the condition of the patient with more accurate way. Automatic screening system will detect and identify precisely the size of Exudates, microaneursyms, Neovasculatures etc from the fundus images. This information is fed into an artificial neural network based classifier to identify Diabetic Retinopathy level of the patients. J .Jenita[4] proposed a method for the extraction of optic disc mainly based on the principal component analysis(PCA) and stochastic watershed transformation. The stages of disease can be find by using Extended minimum and maximum transform. The input for the segmentation is obtained by PCA. The purpose of using PCA is to reduce the dimension of the image and to achieve the grayscale image . Stochastic Watershed transformation is applied in grey-scale images. It is a powerful segmentation tool ,in that the minima of the image represent the objects of interest and the maxima represent the separation boundaries between objects. We can implement the algorithm on public databases for results. The main advantage of the detecting of disease early, it does not need specialists care and reduces the consultation time. Finally the optic disc will be detected with the goal of measuring the cup-todisc- ratio. Thus the system for detecting the patterns of these abnormal cases would supply a excellent benefit.. S. Sekhar[6] describes a novel method to automatically localize both the optic disk and optic disk is localized by means of using the morphological operations and by using the Hough transform. The fovea is localized by means of its spatial relationship with the optic disk, and from the spatial distribution of the macula lutea. Results from two clinical data sets have been promising. Medical image analysis and processing has great significance in the field of medicine, especially in non-invasive treatment and clinical study. Normally fundus images are manually graded by specially trained clinicians in a time cosuming and resource intensive process. A computer-aided fundus image analysis could provide an immediate detection and characterisation of retinal features prior to specialist inspection. Mathematical morphology in image processing is particularly suitable for analysing shapes in images. The two main processes are those of dilation and erosion. These processes involve a special mechanism of combining two sets of pixels. Usually, one set consists of the image being processed and the other a smaller set of pixels known as a structuring element or kernel. Two very important transformations are opening and closing. Opening performs erosion followed by dilation whereas Closing performs dilation followed by erosion. Intuitively, dilation expands an image object and erosion shrinks it. Opening generally tends to smooth the contour in an image, breaking narrow isthmuses and eliminating thin protrusions. Varalekshmi V.R[7] proposed a method based on blood vessel structure obtained using wavelet transform and finally the fovea is localized using the fuzzy c means clustering algorithm. A little bit of information about the optic disc is also used with the structure of the blood vessels to accurately determine the fovea region. This method is divided into two sections. In the first stage the blood vessels are determined using wavelet transform. Geometrically fovea is said to be located at a distance 2.5 times the diameter of the optic disc. This information along with the vessel structure is used in the second stage to localize the fovea region accurately by using fuzzy c means clustering. Fovea is localized by using sliding window technique and Fuzzy C means Clustering algorithm. Sliding window of small size at the point Q is taken and a small region belonging to the fovea region is identified. Similar regions are identified by the Fuzzy C means clustering algorithm .Then the geometrical centroid of the cluster is found to get the fovea region. This algorithm assigns membership to each data point corresponding to each cluster center on the basis of distance between the data point and the cluster center. More the data is near to the cluster center more is its membership towards the particular cluster center .After each iteration membership and cluster centers are updated. Varalekshmi V.R [8] presented a new method that automatically detect the fovea region in retinal fundus image in noisy conditions especially in the case of transmission. In the proposed method a special case of impulse noise is taken and fuzzy based denoising is done and the blood vessel structure is obtained using wavelet transform and finally the fovea is localized using the fuzzy c means clustering algorithm. Blood vessels appear as network like structure and if we look the fundus retinal image carefully we can see that there is no blood vessels around the macula region. This feature is used to find the fovea region. The wavelet transform algorithm is used. First stage denoising is done using fuzzy denoising. In the second stage the blood vessels are determined using wavelet transform.

II. SYSTEM DESIGN

The main objective of the proposed work is to extract the fovea region from the retinal images for detection of eye diseases like diabetic retinopathy. The proposed approach mainly focuses on adaptive thresholding method, which uses threshold values that differentiate the foreground from the background region and helps in extracting the fovea region. Adaptive thresholding is the efficient method of image segmentation, which is very useful in medical imaging. Adaptive thresholding is used to separate desirable foreground image objects from the background based on the difference in pixel intensities of each region .It uses a fixed threshold for all pixels in the image and therefore works only if the intensity histograms of the input image contains neatly separated peaks corresponding to the desired subject and background .Local adaptive thresholding ,on the other hand, selects an individual threshold for each pixel based on the range of intensity values in its local neighborhood .Color images can also be thresholded . one approach is to designate a separate threshold for each of the RGB components of the image and then combine them with AND operation. The intensity variation shows the major difference between the fovea and optic disc. The optic disc has less variation in intensity range when compared to fovea. This separates the fovea from the optic disc in the fundus images. This method is a step by step process ,it includes image acquisition pre-processing ,Adaptive histogram, optic disc detection by morphological operation, blood vessel segmentation and detection of fovea. The architecture diagram of the proposed system is shown in Figure 2.

In Image acquisition the fundus images are collected from the database with the help of ophthalmologist . The image is captured using a power microscope with an attached camera. Databases with pathological images are mostly used.

In Pre-Processing median filters are used for removing low frequency background noise, normalizing the intensity of the individual particles images, removing reflections ,and masking portions of images. Preprocessing is the technique of enhancing data images prior to computational processing that helps in removing unwanted pixels from the fundus images.

Adaptive histogram is used in this method to improve contrast of the gray scale images .it over amplifies the noise in relatively homogeneous regions of an image .Amplification of the images can be limited with the help of adaptive histogram . It is also applied to obtain the background information in the retinal image such as blood vessels ,optic nerve etc.

Optic disc detection by morphological operation includes erosion and dilation method for detecting optic disc. Erosion removes small scale details from a binary image but simultaneously reduce the size of regions of interest too .The dilation of an image helps in producing a new binary image. Morphological operations can also be applied to the grayscale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest.

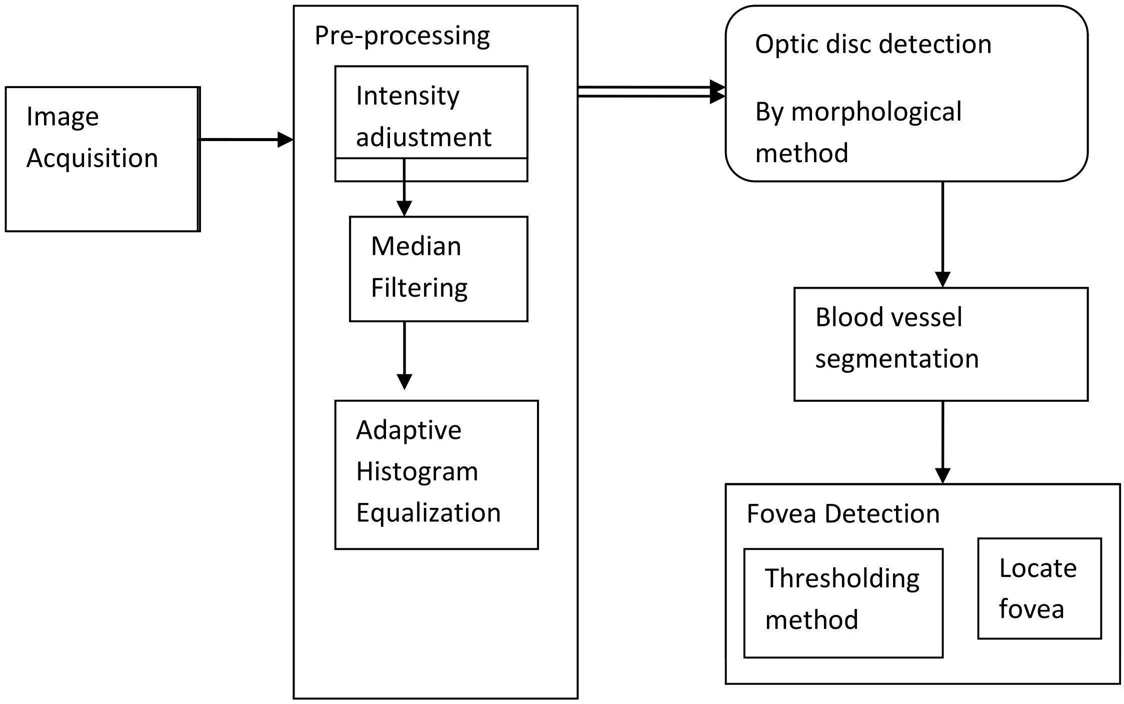

Figure 2 Block diagram for adaptive thresholding method

III. SYNTHESIS RESULTS AND DISCUSSION

Matlab software is used in this method. Matlab is used to do Smoothening the given specimen image as per our requirements. Obtaining green channel image from given specimen RGB. By using Adaptive histogram equalization method enhancing the specimen. Blood vessel segmentation has been take place here. Find optic disc from the difference between dark and brighter regions. Detect the fovea region. Retinal images were collected from lotus eye hospital, Coimbatore and a survey is also carried out on fovea detection for screening eye diseases like diabetic retinopathy.. Figure shows the optic disc detection on various images. This thresholding method gives the results on detection of the fovea detection by morphological operation. Among the above methodology a feasible algorithm to be chosen as proposed method. A new efficient method to localize the fovea in retinal fundus image .The extracted optic disc and fovea region may help in further diagnosis of related diseases. While going through this method above outputs are obtained. Figure 3 be the input image sample which used as the experimental sample. Figure 4 is the median filtered image of given input specimen. Figure 5 shows the adaptive histogram equalisation to increase the contrast of the image. Figure 6 shows the optical disc detection by morphological method. Figure 8 is the blood vessels which are segmented from the input image. The segmented blood vessels obtained due to the darkening and brightening technique. Figure 7 shows the mentioned optic disc in the image. Which is denoted by the using Adaptive thresholding method. Figure 9 shows the exact fovea region by the automatic screening and adaptive equalization method.

Figure 3 Input image

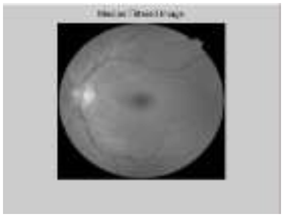

Figure 4 Median filtered image

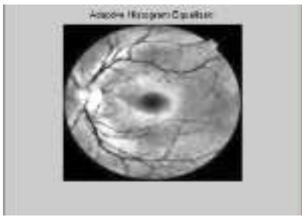

Figure 5 Adaptive ***histogram***

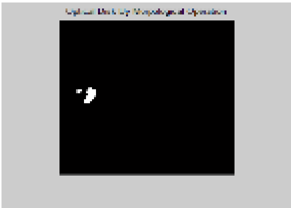

Figure 6 Optical disc by morphological operation

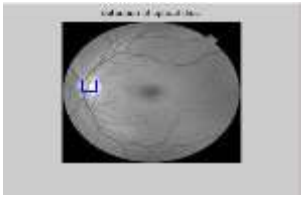

Figure7 Detection of optic disc

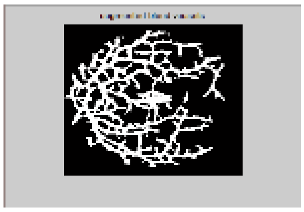

Figure8 segmented blood vessel

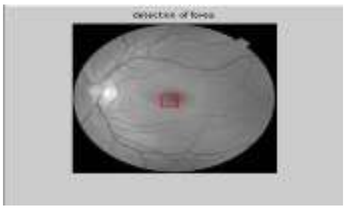

Figure 9 Detection of fovea

IV. CONCLUSION

Various methods are used for detection of fovea in fundus images. In this paper, Adaptive thresholding method which uses a threshold value is used to obtain the center of fovea region. This helps in diagnosis of diabetic retinopathy in early stages. The method used in this work sets different threshold values within a window. Before locating the region of interest, the optic disc and vascular tree in the fundus are extracted by their anatomical position using morphological method. Wellner's method helps in detecting fovea region with an accuracy of 99.25 percent and an improvement of 3.1 percent compared to other methods. As a future work, this can be extended to find the cell density of the fovea to identify the type of diabetic retinopathy.

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