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MICROANEURYSM AND EXUDATE DETECTION FROM COLOR FUNDUS IMAGES USING VARIOUS IMAGE PROCESSING TECHNIQUES

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ABSTRACT

This paper proposes technique for improving the contrast and sharpness and reducing noise of fundus images and methods for detection of Non-proliferative Diabetic Retinopathy symptoms from the preprocessed fundus image. Image Pre processing is done using Dualistic Sub-Image Histogram Equalisation method. After pre-processing the optic disk and exudates in retinal images are segmented out using contour and morphological techniques. Once the contour of a given pattern is extracted, its different characteristics will be examined and used as features which will later on be used in pattern classification. Microaneurysms are segmented out using various morphological techniques from the given preprocessed retinal image. On analyzing the results of the above algorithms, it concludes the presence or absence of DR symptoms in the given retinal image.

INTRODUCTION

Diabetic retinopathy is a complication of diabetes and a leading cause of blindness. It happens when diabetes damages the tiny blood vessels within the retina, the light-sensitive tissue at the back of the eye. Early detection of the disease via regular screening is particularly important to prevent vision loss.The importance of detecting microaneurysms is underscored by the fact that they are the first clinically evident sign of diabetic nonproliferative eye disease, thus the recognition of microaneurysms can be the first step in secondary prevention of diabetic retinopathy progression to the proliferative stage and consequent severe visual loss. Microaneurysms are one of the earliest clinical signs of development of diabetic retinopathy. They generally appear as small round red spots and their diameters are generally less than the diameter of main blood vessels. Increase in number of microaneurysms leads to progression of retinopathy.

Exudates are one of the most important and primary features of diabetic retinopathy and are responsible for hazy views and blindness. Exudates appear as yellow flecks and are caused by lipid occlusions from the damaged blood vessels. Retinopathy is a progressive disease, which can advance from mild stage to proliferative stage. There are three stages: (i) early stage or non-proliferate diabetic retinopathy (NPDR) or background retinopathy, (ii)maculopathy and (iii)progressive or proliferate retinopathy. These stages of DR are shown in Fig. 1.

The early stage is further classified as mild NPDR and moderate to severe NPDR . In mild NPDR, signs such as microaneurysms, dot and blot hemorrhages and hard or intra-retinal exudates are seen in the retinal images. Microaneurysms are small, round and dark red dots with sharp margins and are often temporal to macula. Their size ranges from 20 to 200 microns i.e., less than 1/12th the diameter of an average optic disc and are first detectable signs of retinopathy.Hard exudates are shinny, irregularly shaped and found near prominent microaneurysms or at the edges of retinal edema. In the early stage, the vision is rarely affected and the disease can be identified only by regular dilated eye examinations.

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In moderate to severe NPDR, the signs discussed in mild NPDR are present in excess and in addition to this cotton wool spots, venous beading, venous loops and Intra-retinal micro vascular abnormalities (IRMA) are observed.

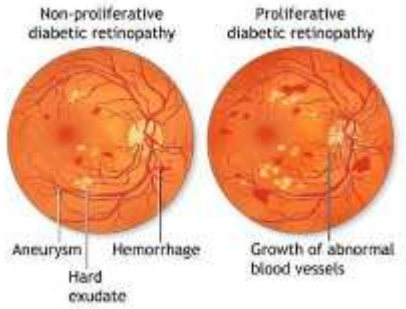

Figure 1. Main stages of Retinopathy with the disorders

M.J. Cree et al.,[1] developed a digital image processing system to quantify and monitor the presence of microaneurysms in retinal fluorescent angiograms. Thomas Walter et al., in his work [2] presented a new algorithm for the detection of exudates with high sensitivity. Exudates are found using their high grey level variation, as well as their contours are determined by means of morphological reconstruction techniques. An automatic method for MA detection and the ability to distinguish between MAs and other dots based on image contrast normalization has been proposed in [3]. Extraction of microaneurysm points using generalized eigen vectors has been suggested in [4].[5] presents a method to construct a MA score map from which the final MAs can be extracted by simple thresholding for a binary output, or with considering all the regional maxima to obtain probability scores. In contrary to the majority of the currently available MA detectors, the future one does not use any supervised training and classification. [6] Proposes an optimal combination of preprocessing methods and exudates candidators using a voting system. Microaneurysms filter algorithm with the concept of vessel enhancement has been proposed in [7]. Kevin Noronha and K.Prabhakar Nayak[8] outlines the principles, methods and algorithms used in the automatic detection of diabetic eye disease. An ensemble-based approach to MA detection has been suggested to suppress the errors of individual algorithms[8]. Gopal Datt Joshi and Jayanthi Sivaswamy in their paper [9] proposed a scheme that can serve as a low cost preprocessing step for high level tasks such shape based recognition and image retrieval.[10] proposes a method for optic disk detection and exudates detection. A Sparse Representation Classifier for MA detection has been proposed in [11].

METHODOLOGY

(a)Preprocessing

The given retinal image is preprocessed using Dualistic Sub-Image Histogram Equalisation. The method first decomposes an input image into two sub-images based on the median of the input image. One of the sub-images is the set of samples less than or equal to the median whereas the other one is the set of samples greater than the median. One of the sub-images is equalized over the range up to the median and the other sub-image is equalized over the range from the median based on the respective histograms. Thus, the resulting equalized sub-images are bounded by each other around the input median, which has an effect of preserving mean brightness.

To find the median of the histogram the following steps are followed:

- First the area of the histogram is found.
- If the area of the histogram is odd then the middle value will be (area+1)/2 else the middle value will be the

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mean of the area and the next value of the area.

- Then the histogram values are added upto that middle value and it is checked whether the added histogram value is less than that middle value or not and that value is kept in a flag (f).
- Then the values upto that flag is added.

$s=X(f+1)-X(f)/\sum^{medi=0}X_i$

where X is the histogram of the image and X_i is the added the histogram up to that middle value. Then the median of the histogram will be flag added with s.

Then the input histogram H(X) is partitioned into two sub-histograms HL(X) and HU(X) by the input median XD. Each of HL(X) And HU(X) is then equalized independently.

(b) Feature Extraction

The features to be extracted from the given preprocessed retinal image are Optic disk, Exudates and Microaneurysm.

Optic Disk and Exudate Segmentation

Exudates and Optic disk are segmented out from the given retinal image using contour and morphological techniques. Contour tracing is one of many preprocessing techniques performed on digital images in order to extract information about their general shape. Once the outline of a given pattern is extracted, its dissimilar characteristics will be examined and used as features which will later on be used in pattern classification. Hence, correct extraction of the contour will produce more accurate features which will increase the chances of correctly classifying a given pattern.

The optic disc attributes such as color and brightness are similar to that of hard exudates. Therefore it is necessary to locate and remove the optic disk during the hard exudates detection process, thereby avoiding false positives. Many factors make optic disk boundary extraction a difficult process. Morphological opening followed by dilation of the image results in the number of connected components as candidate regions for exudates. Each of the connected components is labeled and the basic properties of each component are analyzed. Then, the geometric model based implicit active contour is employed to obtain accurate optic disc boundary. Classical segmentation algorithms such as edge detection, thresholding, and region growing are not enough to accurately find boundary of the optic disc as they do not incorporate the edge smoothness and continuity properties. In contrast, active contour model represent the paradigm that the presence of an edge depends not only on the gradient at a specific point but also on the spatial distribution. These properties make them highly suitable for the optic disc boundary detection application. The regions left out after optic disk segmentation are marked as true candidates.

Microaneurysm Detecti

Extraction of microaneurysm like features is using morphological techniques. The green component of the preprocessed image is threshold from which the edges are detected using canny edge detector. The method uses two thresholds, to identify strong and weak edges, also includes the weak edges in the output only if they are connected to strong edges. This technique is therefore less likely than the others to be fooled by noise, and further likely to detect true weak edges. Holes in the resulting image are filled and unwanted edges are segmented out by taking complement of the image. Using various morphological techniques microaneurysm like features is extracted out from the given retinal image. Identification of true candidates from the given set of candidates is performed is using Hough Transform which detects features of a particular shape like lines or circles in digitalized images.

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CONCLUSION

An efficient method for preprocessing the fundus images was proposed in this paper. We also have proposed a system for extraction of various NPDR features from the preprocessed retinal image. The proposed methods detect only mild NPDR symptoms. As a future work we can extend the proposed method to detect moderate and severe NPDR symptoms cotton wool spots, venous beading, venous loops and Intra-retinal micro vascular abnormalities (IRMA) and can grade the severity of abnormality.

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