Feature Extraction of Diabetic Retinopathy Images

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ABSTRACT
Diabetes is a disease which occurs when the pancreas does not secrete enough insulin or the body is unable to process it properly. This disease affects slowly the circulatory system including that of the retina. As diabetes progresses, the vision of a patient may start to deteriorate and lead to diabetic retinopathy. Diabetic retinopathy is most common occurring disease in the world. The features are extracted from the raw images using the image processing techniques. Since many features have common intensity properties, geometric features and correlations are used to distinguish between them. We also show that many of the features such as the blood vessels, exudates and microaneurysms and hemorrhages can be detected quite accurately. The detection of blood vessels from the retinal images is usually a tedious process. In this work a new algorithm to detect the blood vessels effectively has been proposed. The initial enhancement of the image is carried out using Adaptive Histogram Equalization. This enhanced image is used for the extraction of the blood vessels. The vessel extraction is done based on thresholding technique and the Kirsch's templates. It involves spatial filtering of the image using the templates in eight different orientations.

General Terms
Knn Classification

Keywords
Diabetic retinopathy, Retinal image, Adaptive Histogram Equalization and Kirsch's Template

1. INTRODUCTION
Diabetic retinopathy (DR) is a common retinal complication associated with diabetes. It is a major cause of blindness in both middle and advanced age groups. Color fundus images are used to study eye diseases like diabetic retinopathy. Early detection and treatment of these diseases are crucial to avoid preventable vision loss. The automatic processing and analysis of retinal images could save workloads and may give objective detection to the ophthalmologists. Blood vessel extraction , which is the fundamental step in an automated analyzing system, is investigated in this paper. In this paper, a method to extract the blood vessels based on kirsch template is proposed.[4] The important features component of diabetic retinopathy are Microaneurysms, hemorrhages, exudates, optic disk, fovea is shown in fig.1. After blood vessel extraction the extracted blood vessel is fed to knn classifier for classification and segmentation.

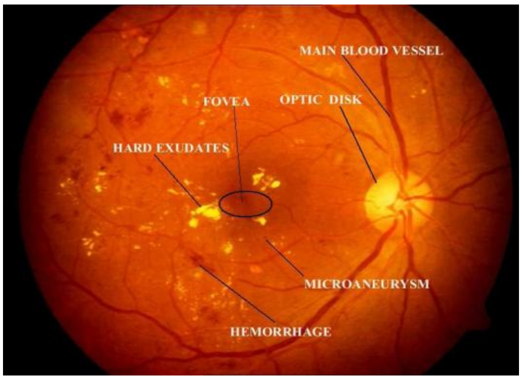


Figure.1. Illustration of various features on a typical retionopathic image.

2. EASE OF USE
Medical image analysis is an area of research that is currently attracting a lot of interest from scientists and physicians. Diabetic Retinopathy (DR) is a frequent micro vascular complication of diabetes and the most common cause of blindness and vision loss in the working population of the world. It has been shown that early detection of DR helps to prevent blindness and visual loss. Hence Vision loss or blindness may be preventable through early detection and timely treatment. Good control of diabetes, blood pressure and cholesterol as well as regular eye examinations may prevent vision loss that's why there is need to detect the diabetic retinopathy at early stage.

3. RELATIVE WORK
Study on different stages of diabetic retinopathy, 124 retinal photographs were analyzed. As a result, four groups were identified, viz., normal moderate, non-proliferative , severe non-proliferative and proliferative. Classification achieved using a three-layer feed forward neural network. The features are extracted from the raw images using the image processing techniques and fed to the classifier for classification.[1] The presence of microaneurysms (MAs) is usually an early sign of diabetic retinopathy. In this paper, presented a new approach for automatic MA detection from digital color fundus images. A successive rejection-based strategy is proposed to progressively lower the number of clutter responses. The processing stages are designed to reject specific classes of clutter while passing majority of true MAs[2]. Novel methods to extract the main features in color retinal images have been developed in this paper. Principal component analysis is employed to locate optic disk; ASM is proposed in the shape detection of optic disk; A fundus coordinate system is established to provide a better description of the features in the retinal images; An approach to detect exudates by the combined region growing and edge detection is proposed. The

success of the proposed algorithms can be attributed to the utilization of the model-based method. [3]

4. METHODOLOGY

4.1. Blood Vessel Extraction

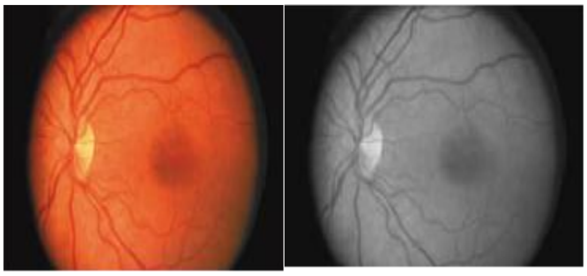
Vessels, fovea and optical disk are mostly used in several applications. The extraction of blood vessels from retinal images can be difficult and the two main factors concerned are the improper retinal image contrast and the uneven background illumination during the acquisition process. The improper contrast is because different vessels have different contrast. Therefore, our aim is to propose an algorithm for the extraction of blood vessels automatically from the retinal image. Blood vessels of different thicknesses can be extracted using kirsch template.[4]

4.1.1 Image selection

The images used here for the experimentation are obtained from any well-known database.

4.1.2 RGB to Gray Conversion

The color image is converted in gray scale version.



(a) (b)

Figure.2. (a) Original Image (b) Gray Scale image

4.1.3 Image Enhancement using Adaptive Histogram Equalization

It is the process of transforming the intensity values of an image such that the histogram of the output image matches approximately the specified histogram. This method increases the Global Contrast of the images. Since the adaptive histogram equalization is capable of improving the image's Local Contrast in bringing out more details of the image**.** It acts as a good tool for the enhancement of the edges.[4]

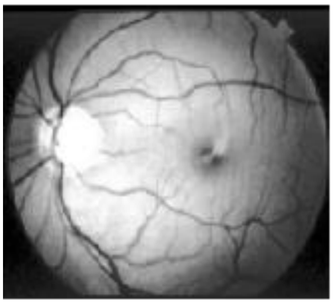


Figure.3. (a) Adaptive Histogram Equalized Image

4.1.4 Fixing the threshold value

Find the pixel value of the enhanced (a1) and reconstructed image (a2). Fix the threshold value. Compare each pixel of both the images and do the following:

a. If a1 and a2 are less than threshold, or greater than threshold, find Mean value and replace

b. If a1 is less than threshold and a2 is greater than threshold, replace with a2.

c. If a2 is less than threshold and a1 is greater than threshold, replace with a1

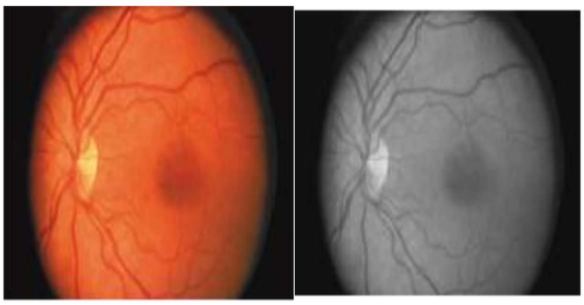
4.1.5 Extraction of Blood vessels using Kirsch's Templates

The extraction of blood vessels from the enhanced image is done based on the Kirsch templates. Kirsch template is used in which eight different orientations is considered. The method involves spatial filtering using the templates of different orientations followed by thresholding technique. Variations in the output image can be obtained by changing the value of threshold used. The masking's of redundant areas of the result are carried out using boundary technique.[4]

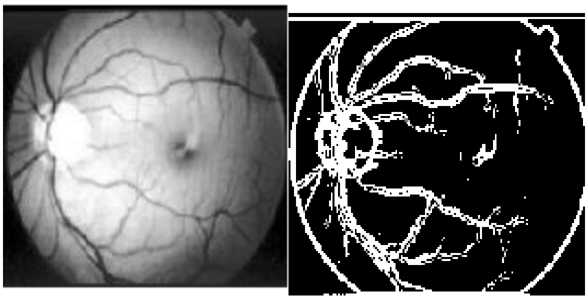
Extracting the retinal blood vessels using edge detectors such as Kirsch For color retinal images, the image segmentation based on the detection of edge(s) is done in three phase. In first phase, a given test image is loaded as a three-channel color RGB image which convert this image into a grayscale-tone image. In second phase, the proposed system proceed the related edge detection mechanism for Kirsch methods. In second and third phase, if necessary for a given method, the proposed system checks the filtered result of (operational) gray value at given point is greater than a given threshold, then it apply this value to the edge image. At the end of the third phase, the proposed system shows the resultant edge image to its end-user.[6]

4.1.6 Smoothing of Image using 2D Digital Filtering

For the purpose of removal of the noisy areas in the image, 2-D digital filtering is applied and the image is smoothened Results of the above procedure are shown in Fig.4.



(a) Original Image **(b) Gray Scale Image**



(c)Adaptive Histogram Equalized Image **(d) Extracted Blood Vessel**

Figure.4. Extraction of Blood Vessel using Kirsch Template

4.2. KNN Classification

After histogram equalization, smoothing and edge detection, the image is divided. The KNN is applied with the values of these pixel for classifying each pixel into vessel or not.[7]

4.2.1 Definition of knn

Instance-based classifiers such as the KNN classifier operate on the premises that classification of unknown instances can be done by relating the unknown to the known according to some distance/similarity function. The intuition is that two instances far apart in the instance space defined by the appropriate distance function are less likely than two closely situated instances to belong to the same class. This is pretty useful , as in the real world , most of the practical data does not obey the typical theoretical assumptions made (e.g. Gaussian mixtures, linearly separable etc.) . Non parametric algorithms like KNN come to the rescue here. It is also a lazy algorithm. What this means is that it does not use the training data points to do any generalization. [7]

4.2.2 The k Nearest Neighbours Algorithm

The way in which the algorithm decides is points from the training set are similar to be considered, is to pick the k closest data points to the new observation, and to take the most common class among these. This is why it is called the k Nearest Neighbours algorithm.[8]

The Algorithm can be summarized as:

a) A positive integer k is specified, along with a new sample

b) We select the k entries which are closest to the new sample

c) We find the most common classification of these entries. This is the classification we give to the new sample

4.2.3 Knn classification

The classification rule may be interpreted as a decision taken based on estimates of the posterior probabilities from the data. The greater the number of samples *N*, the smaller the effect of loss in spatial precision, allowing for larger values of *k* to be used. Many training samples, allowing for good estimates, but demanding a large computational effort. A problem with nearest neighbor techniques is the computational complexity of the search for nearest neighbors among the *N* training samples. Strategies have been studied to improve performance, including efficient searches and reduction of the number of training samples used.[7]

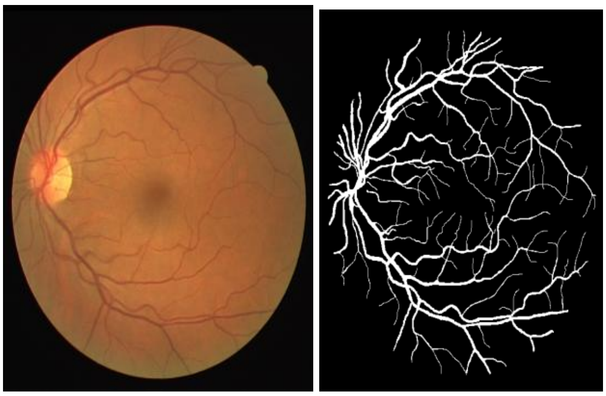
4.2.3.1 The 2-D Gabor Wavelet

Among several available 2-D analyzing wavelets, the Gabor wavelet was adopted for vessel detection here and in previous works, based on the following properties. The wavelet is capable of detecting directional structures and of being tuned to specific frequencies, which is specially important for filtering out the background noise present in retinal images.

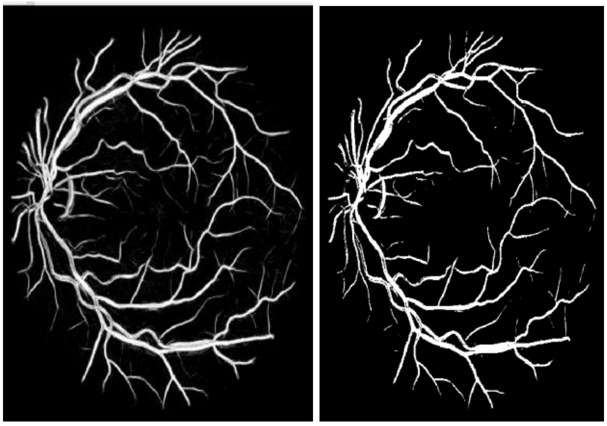
The Gabor wavelet parameters must be configured in order to enhance specific structures or features of interest. In the tests performed, the elongation parameter was set to e = 4, making the filter elongated and **k0** = [0,3], i.e. a low frequency complex exponential. These two characteristics are specially suited for the detection of directional features and have been chosen in order to enable the transform to present stronger responses for pixels associated with vessels. In order to detect vessels in any orientation, for each considered position and scale, the response with maximum modulus over all possible orientations is kept. Thus, for each pixel position and chosen scale, the Gabor wavelet transform is computed from 0 up to 170 degrees at steps of 10 degrees and the maximum is taken ,this is possible because The maximum moduli of the wavelet transform over all angles for various scales are then taken as pixel features for *a* = 2 and *a* = 5 pixels.[7]

4.2.3.2 Supervised Classification and Segmentation

After feature generation and normalization, segmentations are obtained through supervised classification of image pixels into classes i.e vessel pixels and non-vessel pixels. Manual image segmentations can be used to provide these labels. In the experiments performed, the training sets were composed of labeled pixels from several manually segmented retinal images. Due to the computational cost of training the classifier and the large number of samples, subsets of the available labeled samples were randomly selected to actually be used for training.[7] Extracted blood vessel is fed for knn classification and the result of this shown in fig.5.



(a) Original image **(b) Extracted blood vessel**



(c)Posterior Probability **(d) knn Classification**

Fig.5. knn Classification Image

5. CONCLUSION

The proposed system produces edge maps which are based on Kirsch edge detection methods. In addition, the edge map images are relatively free from any noise. The edge-based segmentation using Kirsch compass templates is superior by far to other methods. In this study, the Kirsch template-based implementation is tested on retinal color images.

Blood vessel in retinal images can be classified by using knn classifier. The Gabor wavelet shows itself efficient in enhancing vessel contrast while filtering out noise. Information from wavelet responses at different scales is combined through the supervised classification framework, allowing proper segmentation of vessels of various widths. The *k*NN classifier showed good performance.

6. FUTURE SCOPE

6.1 Feature Extraction

In this we can extract the feature for blood vessel i.e we can calculate standard deviation, entropy of blood vessel. After that main feature component responsible for the diabetic retinopathy that is exudates, microaneurysms and hemorrhages detection is carried out. The location of feature component such as exudates, microaneurysms and hemorrhages is important step.

The detection of the optic disk in fundus images is a very important task because of its similarity in brightness, color and contrast to the exudates. Moreover, the optic disk is an important retinal feature and can be used for registration of retinal images. It can also be used to diagnose other diseases like Glaucoma.

6.2 Predicting the Severity of Disease

The distribution of the exudate lesions about the fovea can be used to predict the severity of Diabetic macular edema. The exudates occurring in the macular region are more dangerous and require immediate medical attention than the ones farther away. Similarly, the size, count and distribution of microaneurysms and hemorrhages is also used to predict the severity of DR. 5 levels for Diabetic Retinopathy based on these criteria: none, mild, moderate, severe, and proliferative. Our system uses these criteria in order to classify each image in these categories.

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