Extraction of Blood Vessels and Exudates from Retinal Images using Image processing Algorithms

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ABSTRACT: The diabetic retinopathy disease spreads diabetes on the retina vessels thus they lose blood supply that causes blindness in short time, so early detection of diabetes prevents blindness in more than 75% of the cases. The retinal image diagnosis is an important methodology for diabetic retinopathy detection and analysis. In this paper the algorithm   first step improved median filter is compared with other filters and second step feature extraction of blood vessels and exudates is done by kirsch algorithm and fuzzy clustering algorithm. the proposed system consists of three stages-first is pre-processing of retinal image using improved median filtering, second stage feature extraction of blood vessel using kirsch edge detection algorithm. This is not only detecting the edges and also the direction of edges and third stage is feature extraction of Exudates. Simulation using mat lab were done using a set of real time images and have been proved that the algorithm holds good for all the images. Blood vessels and exudates can be detected effectively. These results will give the mild and moderate stage of severity in diabetic.

Key words: fundus images, improved median filter, kirsch edge detection algorithm, blood vessel extraction, exudates, fuzzy clustering, severity of diabetic detection.

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I .INTRODUCTION:

Diabetic retinopathy is a micro-vascular complication of diabetes, causing abnormalities in the retinal image. Disorders in retina resulted from special diseases are diagnosed by special images from retina, which are obtained by using optic imaging called fundus. The World Health Organization (WHO) has calculated that, the number of adults with diabetes in the world would increase tremendously: from 135 million in 1995 to 300 million in 2025[6]. In order to reduce the noise effects associated with the processing input image was pre-processed by a filter, then, the retinal fundus image is divided in to three primary components such as Red Channel (R), Green.

Channel (G) and Blue Channel (B)[7]. The green channel is high sensitive to the blood vessels .Blood vessel is one of the most important features in retina consisting of arteries and arterioles for detecting retinal vein occlusion, grading hypertension and early diagnosis of glaucoma. Checking the obtained changes in retinal images in an especial period can help the physician to diagnose the disease. The improper contrast is because different vessels have different contrast; arteries have higher contrast than veins which can be avoided by the adoptive histogram equalization that is a pre-processing method which involves the first is improved median filter. The improved median filter[1] is used to remove salt and pepper noise from the corrupted image. Hence the output is the enhanced image An edge is an abrupt change in the brightness (gray scale level) of the pixels.

The extraction of blood vessels in retinal images is important step in diagnosis and treatment of diabetic retinopathy. For diseased persons the diameter of the blood vessels may vary or otherwise there is a possibility for growth of new vessels when compared with normal person's blood vessels.[8] The blood vessels get swallowed for diabetic patients and it gets narrower for glaucoma diseased patients. Exudates are one of the primary signs of diabetic retinopathy; Automatic exudates detection would be helpful for diabetic retinopathy screening process. Combined color and sharp edge features to detect the exudates. The yellowish objects are detected first; the objects in the image with sharp edges are then detected using Kirsch's mask and different rotations of it on the green component. The combination of results of yellowish objects with sharp edges is used to determine the exudates. The Fuzzy C-Means (FCM) clustering is a well-known clustering technique for image segmentation, Many techniques have been performed for exudates detection, but they have limitations. Poor quality images affect the separation result of bright and dark lesions using thresholding and exudates feature extraction.

II.MATERIALS AND METHODS:

All the images used in this paper are obtained from the government hospital real time patients. There are 110 retinal colour fundus images with an array size of 400 × 600 x 3 pixels, along with the optic nerve contours traced by two experts.

III. PROPOSED SYSTEM

The proposed system consists of two stages-first is pre-processing Where improved median filter is used for the removal of error caused while taking of the image and to reduce the noise and next stage which is the extraction of blood vessel and Exudates using the kirsch edge detection algorithm and fuzzy clustering algorithm. The proposed system for blood vessel and exudates segmentation is illustrated in Fig. 1.
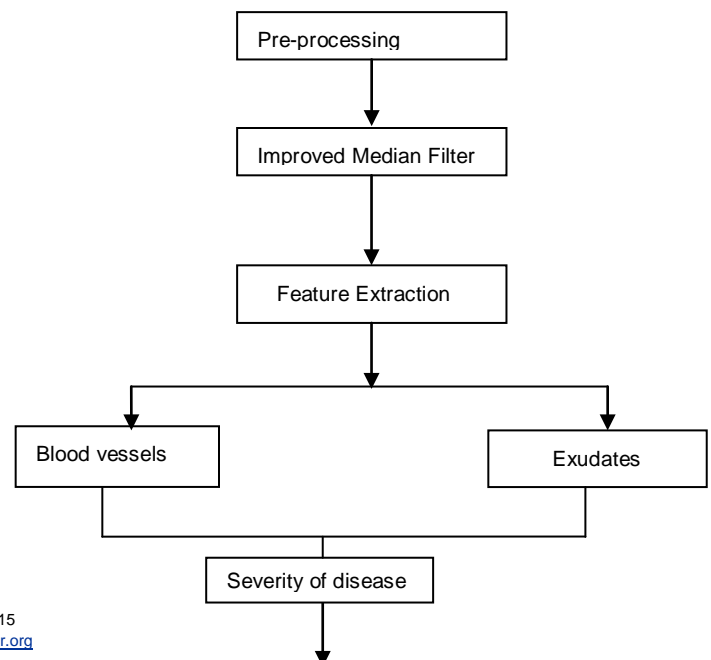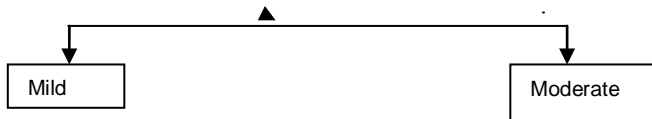
Fig. 1 Proposed System for Blood
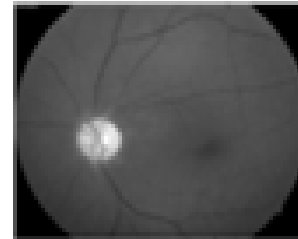
Vessel and Exudates Segmentation

A. PREPROCESSING

The pre-processing step removes variations due to image acquisition, such as inhomogeneous illumination. Techniques such as morphological operations are applied to the input image. The following sessions elaborate the improved median filters are used in pre-processing stage in this paper.

1. IMPROVED MEDIAN FILTER

To remove salt and pepper noise from the corrupted image the below described algorithm is used. The figure depicts the output of improved median filter for the given input retinal image as shown in Fig.2 and the output of the Image after passing through the Improved Median Filter shown in fig 3.

Step 1: A two dimensional window (denoted by 3×3 W) of size 3x3 is selected and centered around the processed pixel in the corrupted image.

Step 2: Sort the pixels in the selected window according to the ascending order and find the median pixel value denoted by Pmed), maximum pixel value (Pmax) and minimum pixel value (Pmin) of the sorted vector V0. Now the first and last elements of the vector V0 is the Pmin and Pmax respectively and the middle element of the vector is the Pmed.

Step 3: If the processed pixel is within the range Pmin < P(x, y) < Pmax , Pmin > 0 and Pmax < 255,it is classifies as uncorrupted pixel and it is left unchanged. Otherwise p(x, y)is classified as corrupted pixel.

Step 4: If p(x, y) is corrupted pixel, then we have the following two cases:

Case 1: If Pmin < Pmed < Pmax and 0 < Pmed < 255, replace the corrupted pixel p(x, y) with Pmed

Case 2: If the condition in case 1 is not satisfied then Pmed is a noisy pixel. In this case compute the difference between each pair of adjacent pixel across the sorted V0 and obtain the difference vector VD. Then find the maximum difference in the VD and mark its corresponding pixel in the V0 to the processed pixel.

Step 5: Step 1 to step 4 are repeated until the Processing is completed for the entire Image.

Fig.2 Input Retinal Fundus Image

Fig.3 Output Improved Median Filter Image

B. BLOOD VESSELS FEATURE EXTRACTION:

The detection of blood vessels from the retinal images is a tedious process. Kirsch algorithm is used to detect the blood vessels effectively has been proposed. Accurate detection of blood vessels from retina is an important job in computer aided diagnosis of Diabetic Retinopathy. Since the blood vessels are distributed in various directions, Morphology processing with multidirectional structuring elements are used to extract the blood vessel from the retinal images.

KIRSCH EDGE DETECTION ALGORITHM

For Kirsch edge detection, the edge image (i.e., detected edges) can be regarded as the space gradient. The Kirsch gradient operator is chosen to extract the contour of the object, The Kirsch edge detection uses eight filters (i.e., eight masks for related eight main directions) that are applied to given image to detect edges. Except the outermost row and the outermost column, every pixel and its eight neighbourhoods in a given image are convolved with these eight templates, respectively. Every pixel has eight outputs. Also, the maximum output of the eight templates is chosen to be the value in given position. This is defined as the edge magnitude. The direction of edge is defined by the related mask that produces the maximum magnitude.

The algorithm steps are given below

Step1. Edge information for a particular pixel is obtained by exploring the brightness of pixels in the neighborhood of that pixel, The algorithm uses a 3x3 table of pixels to store a pixel value .

Step2. The 3x3 table of pixels is called a convolution table, the table is moved across the image, pixel by pixel. For a 256x256 pixel image The lower and upper bounds are 1 and 254, rather than 0 and 255, because we cannot calculate the derivative for pixels on the perimeter of the image.

Step3. For a convolution table, calculating the presence and direction of an edge and is done in three major cases:

Case1. Calculate the derivative for each of the eight directions are north, northeast, east, southeast, south, southwest, west, and northwest. The equations for the Derivatives are written in terms of elements of a 3x3

table.

[0,0]	[0,1]	[0,2]
[1,0]	[1,1]	[1,2]
[2,0]	[2,1]	[2,2]

Table 1: Coordinates of 3x3 convolution table

DerivNE=5x(table[0;1]+table[0;2]+table[1;2])3x(table[0;0]+table[1;0]+table[2;0]+table[2;1]+table[2;2])

DerivSW=5x(table[2;1]+table[2;0]+table[1;0])3x(table[2;2]+table[1;2]+table[0;2]+table[0;1]+table[0;0])

DerivN=5x(table[0;0]+table[0;1]+table[0;2])3x(table[1;0]+table[2;0]+table[2;1]+table[2;2]+table[1;2])

Similarly for other directions

Case2. Find the value and direction of the maximum
       derivative
       EdgeMax = Maximum of absolute values of
                eight Derivatives

       DirMax = Direction of EdgeMax

Note: The following priority order determines
     which direction gets picked if more than one
     derivative have the same magnitude.
       (a) Deriv W
       (b) Deriv NW
       (c) Deriv N
       (d) Deriv NE
       (e) Deriv E
       (f) Deriv SE
       (g) Deriv S
       (h) Deriv SW
  This means that if, for instance Deriv N and Deriv E
  are equal, Deriv N must be Picked.
Case3. Check if the maximum derivative is
       above the threshold.

       if EdgeMax > 400 then
         Edge = true
                     Dir = DirMax
              else
           Edge = false
         Dir = 000

Step4. Step 1 to step 3 are repeated until the
       Process is completed for the entire image

C.EXUDATES EXTRACTION:

Exudates are Small yellow white patches with sharp margins and different shapes. Exudates are one of the early occurring lesions. Exudates are accumulations of lipid and protein in the retina. Typically they are bright, reflective, white or cream colored lesions. They indicate increased vessel permeability and a connected risk of retinal edema. They are a marker of fluid accumulation in the retina. When they present close to the macula centre they form sight threatening lesions. Fuzzy clustering is more natural than hard clustering. It is used to highlight salient regions, extracts relevant features and finally classifies those regions.

FUZZY CLUSTERING ALGORITHM:

Fuzzy clustering is an overlapping clustering algorithm, where each point may belong to two or more clusters with different degrees of membership. The features with close similarity in an image are grouped into the same cluster. The similarity is defined by the distance of the features vector to the cluster centers. Euclidean distance is used to measure this distance and data will be associated to an appropriate membership

value the cluster center is updated until the difference between adjacent objective function.

$$J_m = \sum_{i=1}^{M} \sum_{j=1}^{C} u_{ij}^m \|x_i - c_j\|^2 \qquad (1)$$

Where m is an exponential weighting function that controls the fuzziness of the membership function, it is set to 2 ,M is number of features. C is number of clusters. u_{ij} is the degree of membership of x_i in the cluster j, x_i is the ith of d-dimensional measured data, c_j is the d-dimension center of the cluster, and $\|*\|$ is any norm expressing the similarity between any measured feature and the center.

Fuzzy partitioning is carried out through an iterative optimization of the objective function shown above, with the update of membership u_{ij} and the cluster centers c_j by equation 2 and 3:

$$u_{ij} = \frac{1}{\sum_{k=1}^{C} \left(\frac{\|x_i - c_j\|}{\|x_i - c_k\|} \right)^{\frac{2}{m-1}}} \qquad (2)$$

$$c_j = \frac{\sum_{i=1}^{M} u_{ij}^m x_i}{\sum_{i=1}^{M} u_{ij}^m} \qquad (3)$$

The iteration will stop when Equation 4 is satisfied:

$$\max_{ij} \left\{ \|u_{(k+1)ij} - u_{(k)ij}\| \right\} < \varepsilon \qquad (4)$$

where ε is a termination criterion, 0.00001 for our case. k is the iteration number, it is set to a maximum of 200 for our case. This procedure converges to a local minimum or a saddle point of Jm.

The input to the algorithm is a set of features. the algorithm is composed of the following steps:

Step 1: Initialize the fuzzy partition matrix U = [uij]

(U(0)) by generating random numbers in

the range 0 to 1 subject to Equation(5)

$$\sum_{i=1}^{M} \sum_{j=1}^{C} u_{ij} = 1 \qquad (5)$$

Step 2: At k-step: calculate the centers vectors

C(K)=[cj] with U(K) according to Equation(3) .

Step 3: Update the fuzzy partition matrix U(K),

U(K+1) by the new computed uij according to

Equation (2).

Step 4: Compute the objective function according

to Equation 1. If the difference between

adjacent values of the objective function is

less than termination criterion (ε) then stop

the iteration; otherwise return to step 2.

The output from Fuzzy clustering is a list of cluster centers and n membership-grades for each pixel, where n is a number of desired clusters. A pixel will be assigned to the cluster with highest membership-grade.

IV. SIMULATION AND RESULT

We implemented our proposed method using matlab .The improved median filter is implemented for denoising of highly corrupted images and edge prevention. The kirsch edge detection algorithm works well for the images having clear distinguish between the foreground and background, since the retinal blood vessels can be considered as required foreground information for fundus images kirsch algorithm can be effectively applied. The next extraction exudates. 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 or patch-

es as shown in figures, fuzzy clustering algorithms is used for the extraction of exudates after the extraction of Blood vessels by the fuzzy clustering method to detect the severity of the disease.

From all the images we can say that improved median filter, the kirsch's operator and fuzzy clustering algorithms gives the better results than any other algorithm for the blood vessels extraction and Exudates Extraction.
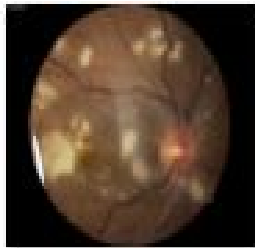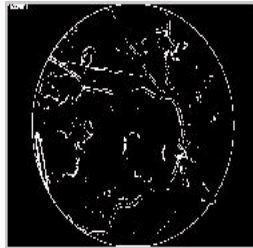

Fig4 input fig 1   kirsch output   exudates output
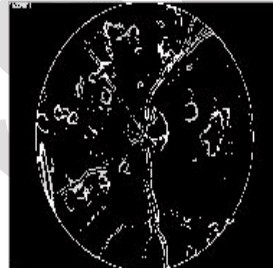

Fig3 input fig 2   kirsch output   exudates output

Fig5 input fig 3   kirsch output   exudates output

V. CONCLUSION.

Retinal images play vital role in several applications such as disease diagnosis and human recognition. The segmented blood vessels can be used for diagnosis of diseases like diabetic, glaucoma and blind spot. In our proposed method the retinal image as the input to the improved median filter is applied for pre-processing The simulation result shows that the improved median filter algorithm can do well with relationship between the effects of noise reduction and time complexity of algorithm, the kirsch edge detection algorithm can set and reset the threshold to obtain the most suitable edge of the image for the retaining the image details better. Fuzzy clustering is more natural and used to highlight salient regions, extracts relevant features ie, Exudates which are the Small yellow white patches with sharp margins and different shapes which will not only detects the diabetes but also the early stage of the diabetes ie, non-proliferative diabetic retinopathy, The simulation results show that the studied method can be applied to different types of image and provide very satisfying results The results of both segmentation and enhancement steps show that our method effectively detects the thin blood vessels and Exudates.

FUTURE ENHANCEMENT

This work determines the presence of Non proliferative diabetic retinopathy in a patient by applying techniques of digital image processing on fundus images taken by the use of medical image camera by a medical personnel in the hospital . In this work , we have investigated and proposed a computer based system to identify normal , Non-proliferative diabetic retinopathy. The kirsch's operator will detect the blood vessels but the output vessels detected is having more width than the original blood vessels so enhancement is required in this operator and the extraction of exudates by the use of fuzzy clustering method only the mild and moderate stage of the diabetes can be known and the third stage cannot be determine. Even though by now some progress has been achieved , there are still remaining challenges and directions for further research, such as , extracting different features and developing better classification algorithms and integration of classifiers to give better performance and reduce the classification errors.

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