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Automatic Extraction of Blood Vessel and Eye Retinopathy Detection

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ABSTRACT

Exudates are one of the primary signs of diabetic retinopathy, which is a main cause of blindness and can be prevented with an early screening process. Diabetic retinopathy eye disease is harmful; causes pressure in eye nerve fibre. It is essential to diagnose it earlier. In this paper we have process on images of retina with the help of Digital Image Processing (DIP) tool in which images are detected and then processed. At last we describe the problem of detecting edges in images as a diabetic retinopathy (DR), macular degeneration and glaucoma. The edge detection problem can be separated into three stages: filtering; detection; and tracing and images separated with the application of different algorithm based on local pixel characteristics which can control the degree of Gaussian smoothing. Filtered images are then applied to a simple edge detection algorithm which evaluates the edge fuzzy association value for each pixel; based on local image characteristics.

Key words: Diabetic Retinopathy (DR), Digital Image Processing (DIP), Macular degeneration and Blood vessel

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INTRODUCTION

Diabetic retinopathy is a complication of diabetes and is a major cause of blindness in developed countries. The patients might not notice a loss of vision until it became too severe, hence early diagnosis and timely treatment is vital to delay or prevent visual impair and even blindness [7]. Retinal vessel segmentation can simplify screening for retinopathy by reducing the number of false positive results in micro aneurysm detection and may serve as a means of image registration from the same patient taken at different times by delineating the location of the optic disc and fovea [3]. However, manual detection of blood vessels is not simple because the vessels in a retinal image are complex and have low contrast. Detecting abnormalities such as venous looping or beadings is critical for early treatment as they are in most cases indication of potentially sight-threatening retinopathy. In order to utilize these useful characteristics of retinal blood vessels this is very important to obtain their locations and shapes accurately.
Blood vessels appeared as networks of either deep red or orange-red filaments that originated within the optic disc and were of progressively diminishing width. Several approaches for extracting retinal image vessels have been developed which can be divided as; one consists of supervised classifier-based algorithms and the other utilizes tracking-based approaches. Supervised classifier-based algorithm usually comprise of two steps.

(i) A low-level algorithm produces segmentation of spatially connected regions.
(ii) These candidate regions are then classified as vascular or non-vascular.

The application of mathematical morphology and wavelet transform was investigated for identification of retinal blood vessels [1]. In a follow-up study, a two-dimensional Gabor wavelet was utilized to initially segment the retinal images [3]. A Bayesian classifier was then applied to classify extracted feature vectors as vascular or non-vascular [2]. Tracking-based approaches utilize a profile model to incrementally step along and segment a vessel [12]. Vessel tracking proceeded iteratively from the papilla, halting when the response to a one-dimensional matched filter fell below a given threshold. The tracking method was driven by a fuzzy model of a one-dimensional vessel profile [3]. One drawback to these approaches is their dependence upon methods for locating the starting points, which must always be either at the optic nerve or at subsequently detected branch points. Blood vessels were detected by means of mathematical morphology [4]. Matched filters were applied in conjunction with other techniques such as genetic algorithms and piecewise thresholding [5]. Blood vessels were identified by means of a multilayer perceptron neural networks for which inputs were derived from a principle component analysis of the image and the edge detection of the first principle component. Blood vessels were detected using two-dimensional matched filters [7].

DIGITAL IMAGE PROCESSING

Image processing is a physical process which is used to convert an image signal into a physical image. This image signal can be either digital or analog. The output can be an actual physical image or the characteristics of an image. The common type of image processing is photography. Due to this process, an image is captured using a camera to create a digital or analog image. The image is processed using the appropriate technology based on the input source type In order to produce a physical picture. The image is stored as a computer file in digital photography. Then this file is translated using photographic software to generate an actual image. At the time, the photograph is taken the software translates this information into an image, the colors, shading and nuances are all captured. The image is burned into a film using a chemical reaction triggered by controlled exposure to light, when images are creating using analog photography. After that, the image is processed in a darkroom using special chemicals to create the actual image. Then this process is decreasing in popularity due to the advent of digital photography and it requires less effort and special training to product images.

Firstly, the image is converted into a digital form before going to processing an image. It is Digitization includes sampling of image and quantization of sampled values. The processing is performed after converting the image into bit information. These processing techniques are Image reconstruction, Image enhancement, and Image compression.

Image Enhancement
It refers to accentuation or sharpening of image features such as boundaries or contrast to make a graphic display more useful for display & analysis.

Image Restoration
It is concerned with filtering the observed image to minimize the effect of degradations. The effectiveness of image restoration depends on the extent and accuracy of the knowledge of degradation process as well as on filter design.

Image Compression
The image compression is concerned with minimizing the no of bits required to represent an image.

EYE

The human eye this gives the sensation of vision including color differentiation and perception of depth due to the presence of rods and cones in the retina (sensor tunic). Neural layer present in the retina plays a direct role in vision and visual processing. The most important parts of the retina are optic disc (OD), macula, fovea and blood vessels. OD is the brightest region having elliptical shape which appears bright orange pink with a pale center. OD is called blind-spot as it lacks photoreceptors. The blood vessels are emanating out from the OD. Lateral to the blind spot of the eye a hazy dark region having oval shape with a diameter of nearly 0.4mm is present. It is called macula lutea (yellow spot). The centre of the macula is called fovea (having size of a pin head), which contains only the cones and helps in acuity vision. Macula contains mostly the cones and its density declines gradually from the edge of macula to retinal periphery. The neural retina is nourished by the blood circulation in the central artery and central vein, which leave the eye through the centre of the OD. These vessels give rise to a rich vascular network, which clearly visible non-invasively by the help of ophthalmoscope [9].

Blood Vessel
The retinal blood vessels are usually referred to; arteries and veins. Then artery and central vein normally appear near each other in the nasal side of the optical disc centre. Blood vessels are clearer in the green component. Information about the structure of the blood vessels can help to classify the severity of the disease and may also serve as a reference during operation. And two strategies have been used for the detection of blood vessels in image. One is the detection of edges; and the other is monitoring that requires a priori knowledge of the position from the image. Information about blood vessels can be used in grading disease severity or as part of process of automated diagnosis of diseases with ocular manifestations. Blood vessels can act as landmarks for localizing the optic nerve, the fovea (central vision area), and lesions. As a result of systematic or local ocular disease; the blood vessels can have measurable abnormalities in diameter and color. For example, central retinal artery occlusion usually causes generalized constriction of retinal arteries; hypertension may result in focal constriction of retinal arteries and central retinal vein occlusion typically produces dilated tortuous veins, arteriosclerosis can cause the arteries to acquire a copper or silver color, and diabetes can generate new blood vessels (neovascularisation). Thus, a reliable method of vessel detection is needed, which preserves various vessel measurements [6].

Optic Disc
The location of optic disc (OD) is of critical importance in retinal image analysis. In normal images, the OD is brighter than any part of the retina and is normally circular in shape. This is also the entry and exit point for nerves entering and leaving the retina to and from the brain. A typical retina image, the bright OD. OD detection helps the ophthalmologists to find whether the patient is affected by diabetic retinopathy or not [10].

NEURO-FUZZY

Neuro-fuzzy systems are the soft computing methods that combine in various ways neural networks and fuzzy concepts. The following points are two main parts of Neuro-Fuzzy as:

- ANN – nervous system – low level perceptive and signal integration.
- Fuzzy part – represents the emergent 'higher level' reasoning aspects.

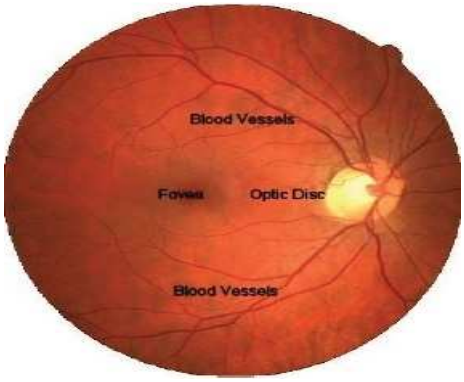

Fig. 1 Eye

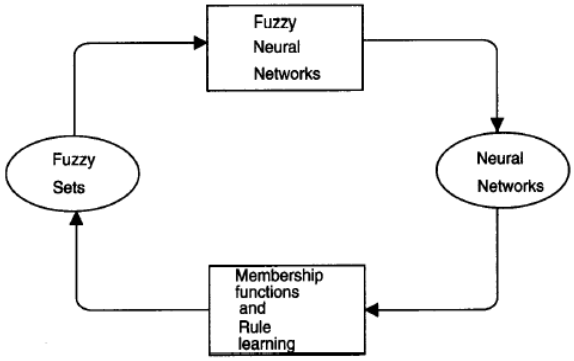

Fig. 2 Working of Neuro-Fuzzy

THE ANFIS SYSTEM

The ANFIS system may be defined as in the following points:

- Adaptive Network-based Fuzzy Inference System.
- Neuro-fuzzy system that can identify parameters by using supervised learning methods.
- Sugeno-type fuzzy system with learning capabilities.
- Nodes have the same function for a given layer but are different from one layer to the next.
- Learning algorithm is a hybrid supervised method based on gradient descent and Least-squares.
- Forward phase: signals travel up to layer 4 and the relevant parameters are fitted by least squares.
- Backward phase: the error signals travel backward and the premise parameters are updated as in back-propagation.
- Fuzzy toolbox Matlab.

METHODOLOGY

The following flow chart shows the proposed work of Retinopathy as:

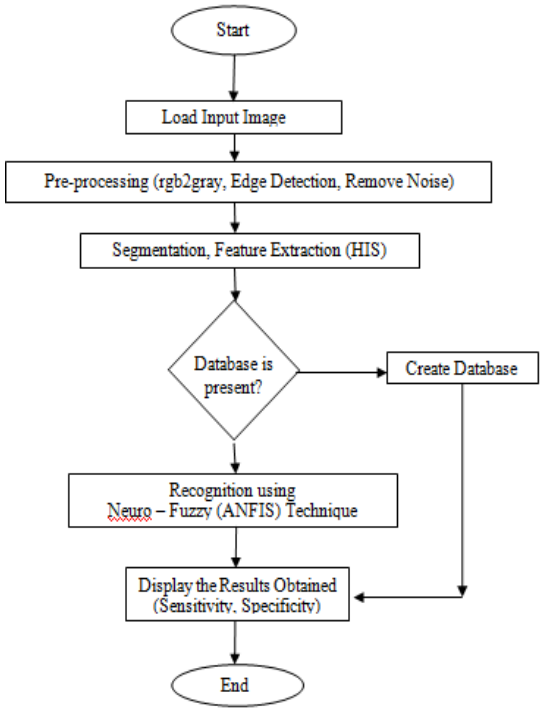

Fig.3 Flow Chart of Proposed Work

RESULTS

MATLAB software is used for detection of diabetic eye retinopathy and extraction of infected blood vessel by vessel tracking approach. Thus, based on this technique, proposed system has been tested on number of retina images and performance of algorithm is detected in terms of sensitivity, specificity and bit error. Following results have been obtained:

Fig.4 Hue equalized RGB image

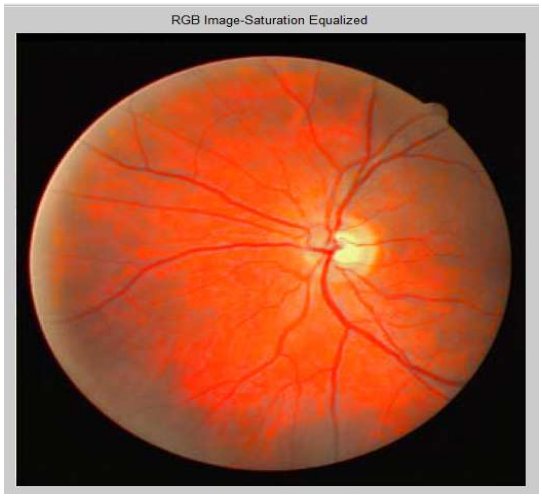

Fig.5 Saturation equalized RGB image

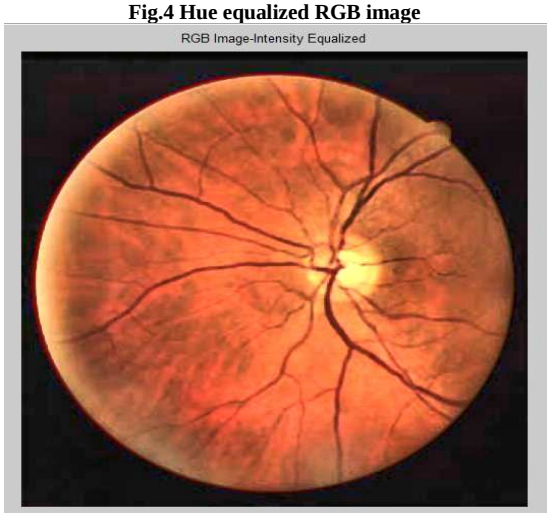

Fig.6 Intensity equalized RGB image

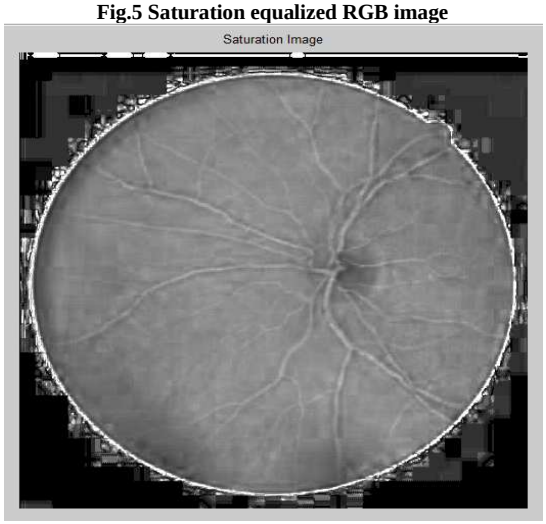

Fig.7 Saturated image

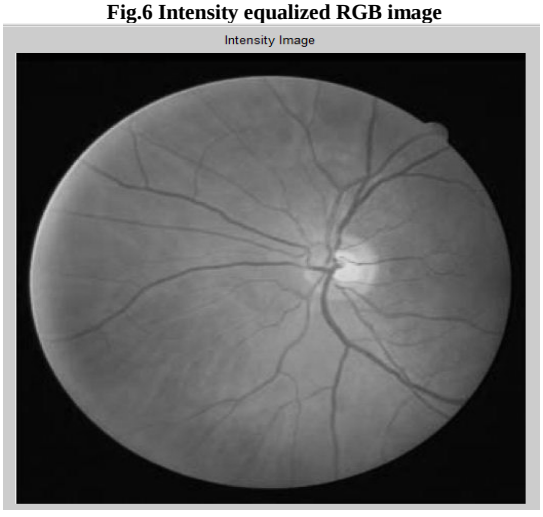

Fig.8 Intensity image

	Sensitivity(%)	Specificity(%)
Proposed method	87.4000	90.4400
Morphological filter	86.3900	91.2800
Bayesian classifier	75.2500	97.2200
NN method	70.6700	98.0100

Fig.9 Results of Proposed Method

Fig.10 Bit error rate

CONCLUSION

The different pathological conditions (diseases) of retina are: diabetic retinopathy (DR), macular degeneration and glaucoma. One of the serious complication in modern era is the Diabetic Retinopathy (DR) occurs due to progression of diabetes. It causes damage to the different parts of the retina and leads to vision loss. DR is a progressive disease which approaches from non-proliferative diabetic retinopathy (NPDR) to the proliferative diabetic retinopathy (PDR). Micro aneurysms, the small red dots in the color photographs are the first clinical sign for the presence of DR. During the PDR stage the tiny blood vessels are blocked. So, new vessels grow to provide nutrients to the retina. These vessels are fragile and causes bleeding into the vitreous, which results cloud vision. The new vessels lead to retinal detachment and vision loss. Age related macular degeneration (AMD) occurs in the older group peoples, which affects the macula and the central vision. Glaucoma is a specific optic nerve disease occurs due to the progressive break down of nerve fibers and causes an elevated pressure in the optic nerve head (ONH). ONH contains the optic nerve fibers, which carries the sight image information to the brain. Therefore algorithm is made to overcome these problems. This algorithm can be extended to detect brain haemorrhages as well. Further improvement can be made to this algorithm by calculating total infected area of eye.

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