Detection of diabetic retinopathy

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ABSTRACT:

Diabetic retinopathy is a serious sight threatening complication of diabetes which causes damage to the blood vessels of the retina in people . Diabetic retinopathy is the most common cause of blindness of the eye. Therefore, early detection of diabetic retinopathy is of critical importance. But diabetic retinopathy is still screened manually by ophthalmologist using fundus images due to insufficiently reliable existing automated diabetic retinopathy detection systems. Hence, our work aims at automatic diabetic retinopathy detection from fundus images using a deep learning approach with improved accuracy than existing work. The proposed approach consists of two steps. In the first stage, pretreatments were performed on fundus images to standardize them to size. In second stage, only relevant features are selected using particle swarm optimization which could yield improved accuracy. In the third stage, classification was made by Convolutional Neural Network which could predict the output as healthy or defective.

Keywords: Diabetic retinopathy, fundus images, Convolutional neural network, Particle swarm optimization.

1. INTRODUCTION:

Diabetic retinopathy is the most severe of the several ocular complications of diabetes. It has few ophthalmic symptoms until visual loss develops. The rising situation in the developing world suggests diabetic retinopathy may soon be a major problem in the clinical world. Recent survey stated that it is the fourth frequently occuring chronic disease, which will increase to position

of second by the year 2030[1]. At present, there are 52. 8 million people who are diagnosed with diabetes that will rise by 64 million in 2030[1].

The major symptoms of Diabetic retinopathy are Micro aneurysms, hard exudates, soft Exudates . The Micro aneurysms, which occur due to dilatations of the blood capillaries and they appear as dark red spots on the retina. Hemorrhages occur when the microaneurysms burst. Bright-yellow colored Lesions such as hard exudates occur as a result of fluid leaking into the retinal surface from the capillaries or from Microaneurysms.. Another bright white colored lesions, called the soft Exudates or cotton wool spots occur occlusions of the nerve fibre layer. Diabetic Retinopathy is a progressive disease. The first stage of retinopathy is known as Non-Proliferative Retinopathy, during which the retinal lesions appear and increase as the disease progresses. Proliferative Retinopathy that might leak blood into retina causing permanent blindness. The fig[1] shows the differentiation of normal eye and defective eye.

At present, DR is still screened manually by ophthalmologist using fundus images due to insufficiently reliable existing automated DR detection systems. But manual screening demands skilled professionals for the diagnosis and it is time consuming. Hence it is important to do automatic diagnosis with high accuracy for the disease and classify it using deep learning technique which will drastically reduce man power and results in early deduction of diabetic retinopathy.

2. RELATED WORKS:

Our work proposes several steps to detect diabetic retinopathy in early stages. Comparative study on all the papers regarding diabetic retinopathy is presented below.

2. 1 Detection of Lesions and Classification of DR

Rapeeporn et al [2] proposed a model that will detect diabetic retinopathy as well as to classify the severity of the disease. The more serious DR shows one of the symptoms of venous beading (VB), neovascularization and intra-retinal micro-vascular abnormalities (IRMA). The extract the lesions on the retina especially blood vessels, exudates and micro aneurysms. Features such as area, perimeter and count from these lesions are used to classify the stages of the disease by applying artificial neural network (ANN).

Image processing is done with images that are initially kept to a standard size 640 x 480. Preprocessing is done to remove noises, and converting to gray scale. The green channel can give the higher contrast than red and blue. So, the input image is turned to green Channel and intern the green channel image is converted using compliment function (work flow of this model is shown in fig[2]). Deduction of Exudates is next step which have different shapes, sized and usually bright or yellow in color. Moreover, they have the highest contrast compared to other parts on the retina. Deduction of Micro aneurysms (MAs) is done using green channel image. To adjust the contrast of the image, adaptive histogram equalization is applied. The proposed work of this model define four classes namely R1, R2, R3 and R4. R1 can be classified by checking the existence of lesions. R2, the need to detect and classify the count of MAs only. However, for R3 the need to detect

exudates. R4, there are one more criteria for abnormalities of blood vessels. Pattern recognition networks for classification.

After detecting the features, the extracted features are applied to artificial neural network, for staging disease severity. Extraction of necessary features is done and classified using ANN classifier. This method performed up to accuracy 96% .

2. 2 K-Means and Fuzzy Logic to classify DR

Md. Jahiruzzaman et al[3] proposed the detection of diabetic retinopathy related exudates and hemorrhages in fundus images of the retina. This study presents an effective approach to detect exudates and hemorrhages in retinal fundus image and classify the diabetic retinopathy. A k-means color compression technique is used to cluster the fundus image in different region of interest reducing color dimension. The different parts of diabetic fundus then segmented out and analyzed through the region properties attributes. Finally, the recognition of diabetic retinopathy was done by the knowledge based fuzzy inference system (FIS) with these effective attributes through experiment and trail basis.

Separation of the eyeball from the background is done by detecting the eyeball edge using sobel operator. Sober technique is a gradient based edge deduction technique. To choose the exudates, k-means clustering for color based segmentation of the fundus image is used. To compress, similar colors can be grouped together and other components can be neglected redundant components.

The red component of the color compressed image is extracted, so that we find the histogram of this image. Binary image is then computed to segment the exudates so that segmented exudates are filled using morphological opening technique. Fuzzy inference system (FIS) with the effective attributes is developed and used. By using input membership function, the crisp inputs are converted into fuzzy sets of input variable. Using If then fuzzy rules, The fuzzy input set of variables then converted to fuzzy output set of variables(work flow of this model is shown in fig[3]). The fuzzy output set of variables then converted to outputs by using output membership function

The accuracy of the detector is found as 92. 3% . The retinal fundus image database images are successfully classified by fuzzy logic classifier with accuracy up to 93. 67%.

2. 3 Classification of DR stages using CNN

Ratul Ghosh et al[4] proposes Convolutional Neural Networks (CNNs) approach is proposed to automate the method of Diabetic Retinopathy(DR) screening using color fundus retinal photography as input. The images are classified based on the severity of DR.

For proper use of the CNN, the images are cropped and resized to squares of 512 pixels. Brightness of each of the image is adjusted after pre-processing by converting it to float representation followed by adding delta value to all components resulting in converting into the original data type. Image is brought to normal scale by normalization. The data is zero-centered followed by dividing each dimension by its corresponding standard deviation. Xavier

initialization is used(as shown in eqn 1) so that it makes sure the weights are on scale while keeping the signal passes through many layers.

W = random (fanin, fanout)/(sqrt(fanin)/2) ——————————-> eqn 1.

A soft max layer is used for the final prediction. An effective regularization technique known as dropout is used. During the training, dropout is performed by keeping a neuron active with some probability. By setting the hyper parameter as 0. 50, it would result in the maximum amount of regularization. Updation of the parameter by Nester momentum, with fixed number of 250 epochs

which is used to train the networks. There occurred the class imbalance problem which was tackled by training the class-balanced subset.

On the data set of over 30, 000 images our proposed model achieves around 95% accuracy for the two class classification and around 85% accuracy for the five class classification on around 3, 000 validation images.

2. 4 Classification of DR using Support Vector Machine

Arusha Roy et al [5] deals with the filter based retinal vessel extraction, exudates detection using Fuzzy C means, detection and removal of optical disk using Convex Hull. Support Vector Machines (SVM) is used to classify the fundus images into Normal and Non-proliferative Diabetic Retinopathy (NPDR) or Proliferative Diabetic Retinopathy (PDR). Fuzzy C means algorithm has been used primarily which results in the extraction of the exudates and the optical disk. Further techniques were needed to be applied to get the

disk detected and separated from the exudates. The Optic Nerve detection has been focused in the paper which eases the process of eliminating the Optical Disk. Convex Hull being one of the efficient techniques has been used to detect the Optical Nerve. The area of the Optical Disk is calculated taking the radius of the Optic Nerve which surrounds the disk.

Other than exudates, the detection of the stage of Neovascularization is used here to confirm the stage of Diabetic Retinopathy- Proliferative Diabetic Retinopathy (PDR) stage. The detection of Retinal vessels is performed using cascaded Gaussian and Median Filter followed by a top hat filter of specific size Support Vector Machine (SVM) is a two class classifier which is used here in order to characterize the extracted features and give the class of the fundus image effectively. The work flow of this model is shown in fig[4].

2. 5 Wavelet Based Detection of DR

PR Anjali et al [6] proposed a novel wavelet based method is used for automatic exudates detection in retinal images of patients with diabetic retinopathy. To check the exudates detection performance, the proposed method was evaluated.

Here, for exudates detection, a novel wavelet based approach is done because it is efficient both in terms of accuracy and computational complexity. Wavelet transform is an efficient novel method for exudate detection . The whole retinal image divided into 3 × 3 equal size of non-overlapping blocks. Since optic disk most probably falls in the central region of retinal image, hence each block is decomposed with standard two band

wavelet transform separately. Wavelet transform is used to decompose the retinal image into number of spatial frequency channels which in turn responds to an explicit spatial location. To do, Hard Exudate Detection, we need to first detect OD with wavelet based approach. Now, Remove OD area and detect Circular border and remove it from the image. Use adaptive histogram of original gray scale to detect the non-exudate region in image and convert it into binary with Threshold = 0. 82.

Experimental results indicates that with the proposed method, the exudates were correctly identified with accuracy of 86. 67% .

CONCLUSION:

In this survey, various works have been studied and comparison is made to find the best work to detect the diabetic retinopathy and concluded that Convolution Neural network is efficient way to detect diabetic retinopathy.