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Detection of Diabetic Retinopathy from Retinal Image Using Deep Learning

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ABSTRACT –

A great challenge in the biomedical engineering is the non-invasive assessment of the physiological changes occurring inside the human body. The complexities associated with the human eye is extremely difficult. The digital cameras capture the retinal images which are used to detect the abnormalities. Conventional disease identification techniques from retinal images are mostly dependent on manual intervention. The success rate of the technique is low due to human observation. The people suffering from long standing diabetes is due to diabetic retinopathy in retina. It is a multistage progressing disease namely NDPR and PDR. The person affected by diabetic retinopathy. By using segmentation of anomalies fundus image can be preprocessed by image processing technique. Feature extraction is done and the detected features are used to classify the different stages of diabetic retinopathy. The class identification technique used is Random rest, and the accuracy obtained is 89.9 percentage.

Keywords : Microaneurysms, Hemorrhages, Random Forest, Feature extraction.

I. INTRODUCTION

The complication of diabetes is Diabetic Retinopathy(DR) that can affects human eye. It is caused by damage to the blood vessels of the retina - the light-sensitive tissue at the back of the eye. The first stage is only mild vision problem.

Over a period of time, two-third of all type2 and all type1 diabetics are anticipated to diabetic retinopathy. Eventually, it can cause blindness. In the World, it can cause blindness. From the survey around 80 percent of population having diabetes.

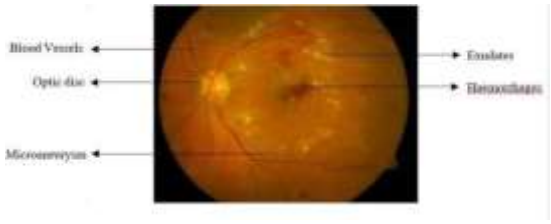
Diabetic retinopathy is classified into two types:

a) **Non-proliferative diabetic retinopathy (NPDR) -** It is the early stage of the disease where it leads to cause mild and non existent. In NPDR, the blood vessels in the retina are weakened. The microaneurysms are called tiny bulges in the blood vessels and it leak fluid into the retina. Because of this, may lead to swelling of the macula.

b) **Proliferative diabetic retinopathy (PDR) -** It is the disease which is the most advanced form. In this, It deprive the oxygen in retina during circulation problem. As a result, the gel like fluid fills the back of the eye and in the retina the fragile blood vessels begins to grow. The blood vessels which is up to date leaks blood into the vitreous causing clouding vision.

- **Fundus Image:**

It is the image of the internal structure of the eye captured using specialized fundus cameras that consist of an intricate microscope attached to a flashed enabled camera. The main structures that can be visualized on a fundus image are the central and peripheral retina, optic disc and macula.



- **Retinal abnormalities:**

The common abnormalities found in the human retina are Microaneurysms, Hemorrhages and Exudates as shown in Figure 1.2

- **Microaneurysms:**

A small swelling that forms on the ends of tiny blood vessels. At nearby tissue the leakage of blood and small swellings are breached. The microaneurysms is the earliest visibility of diabetic retinopathy.

- **Hemorrhages:**

The bleeding occurs in the retina for the disorder of Retinal hemorrhage. Retinal hemorrhages that take place outside of the macula if left undetected for many years, and may sometimes only be picked up when the eye is examined in detail by ophthalmoscopy or fundus photography. The severe impairment of vision is caused by retinal hemorrhages.

- **Exudates:**

As Diabetic Retinopathy progresses, a fluid rich in protein and cellular elements that oozes out of blood vessels due to inflammation and is deposited in nearby tissues. The spatial random yellowish or whitish patches of various sizes, shapes and location are manifested in exudates. The major cause of visual loss in Non-Proliferative forms of DR are the visible sign.

II. LITERATURE SURVEY

[1] In this work, an algorithm has been developed for the identification of the different stages of Diabetic Retinopathy (DR). The irregularities in the retinal blood vessels such as changes in the perimeter, area of spread is considered as a measure of severity of DR. The input fundus images are obtained from the MESSIDOR Database. A total of 100 images are analyzed in the present study. These images are graded into four subsets as Grade 0, 1, 2 and 3. Grade 0 corresponds to normal retinal images or no DR. Grade 1 images correspond to Mild Non-Proliferative Retinopathy. Grade 2 images correspond to Moderate and Severe Non-Proliferative Retinopathy. Grade 3 images correspond to Proliferative Retinopathy. This algorithm provides 85% accuracy.

Segmentation Method:

In the areas of feature detection and feature extraction, edge detection is a fundamental tool in image processing. The result of applying an edge detector to an image leads to a set of connected curves that indicate the boundaries of objects, the boundaries of surface markings and the curves correspond to ends up in surface orientation. Thus, applying an edge detection algorithm to a retinal image significantly extract the blood vessels. For edge detection technique the non-linear Sobel filter is employed. A nonlinear filter replaces each pixel value with a nonlinear function of its surrounding pixels. The nonlinear filters operate on a neighborhood as like linear filters. The nonlinear Sobel filter is a high pass filter that extracts the outer contours of objects. The light intensity along with vertical and horizontal axes act as a highlights of significant variations.

Machine Learning (ML) Model:

No ML model has been used here, the fundus images are classified in to grades based on the perimeter and area values of the blood vessels.

[2] This work proposes an algorithm for identification of the different stages of diabetic retinopathy. The early signs of DR Microaneurysms are considered for classifying the different stages of the disease. The input fundus image is pre-processed using median filter to remove salt and pepper noise. MAs look like isolated patterns and are detached from the vessels. Based on the shape, intensity level and size the features of Microaneurysms can be extracted. After the detection of Microaneurysms, Depending on the count of detected Microaneurysms, the images are classified whether it is normal, mild moderate and severe by using SVM. This method provides 83% accuracy, 74% sensitivity and 100% specificity.

Segmentation Method:

As look like an isolated pattern and are detached from the vessels. The features of microaneurysms can be extracted based on the shape, intensity level and size. As soon as image is preprocessed, the candidates Microaneurysms are segmented through isolating them from veins. Blood vessels are huge in subject and are related section, hence can recognize from MA situated on area. By the experimentation the threshold value is chosen to remove blood vessels. The threshold value are eliminated if the object has greater area. For the experimentation, two threshold values are chosen to cast off noise objects having greater area and scale down than MAs. The consequential image having objects which have the identical region and some of them are MAs. From the noises, MAs are identified which are in irregular shape. The noise having same area as Microaneurysms are removed based on the major and minor axis. Based on perimeter and circularity the Microaneurysms are detected. Based on the resultant image from the previous segment the canny edge detection is performed.

ML Model:

SVM training approach is utilized to compare coaching information to discover a fine viable way to categories the DR images into their respective categories, natural, slight, moderate and severe. It is robust procedure for the categorization of information and deterioration. It appears for a hyper plane that may linearly separate courses of objects. The separate classes of item looks for a hyper plane linearly. It is used to utilize and recognize different classes. It is used to differentiate the various categories.

The diabetic retinopathy patient is diagnosed by fundus retinal image. Developed system used green plane out of RGB component of image due more clarity. Green plane is selected because red planes have saturated features and blue plane has low intensity features while contours are easily viewed in green plane due to proper intensity features. Median filtering operation and histogram equalization operations is performing on a green plane to analyze various features in DR patient. In the given system defects boundaries are created around the affected areas of the retina image and calculating the count of blood vessels.

[3] Areas. According to the area of DR feature component and with the help ANN by training and defining weights to the previous layer. Severity of the disease can be analyzed. Achieved an accuracy of 86.36%.

Segmentation Method:

Morphological operation like closing and opening (Dilation or Erosion) is required to identify feature accurately with the help of threshold value for Defects. Besides that Hough transform is used to isolate the features of the particular shape within an image. In the given system defects boundaries are created around the affected areas of the retina image and calculates the areas.

ML Model:

Based on the neural structure of the brain, artificial Neural Networks are relatively crude electronic model. ANN is also called perceptron. Single layer perceptron's are used to classify linear data, by introducing additional hidden layers nonlinear data can be classified. A multilayered perceptron is used with one input layer, one hidden layer and one output layer is being used. According to the area of DR feature component and with the help Artificial Neural Network (ANN) by training and defining weights to the previous layer. Severity of the disease can be classified.

[4] This system proposes classification of fundus images using random forest algorithm. There are 778 images in total from that 287 features are extracted. After extraction classes are formed as class 0, class 1, class 2, class 3 having 360, 88, 142, 188 respectively. The Random Forests algorithm is one of the best among classification algorithms - able to classify large amounts of data with accuracy Random Forests an ensemble learning method for classification and regression that construct a number of decision trees at training time and outputting the class that is the mode of the classes output by individual trees where each tree depends on the values of a random vector sampled independently with the same distribution for all trees in the forest. In this, a group of weak learners can come together to form a strong learner is the basic principle. Achieved an accuracy of 74.93%.

Segmentation Method:

No segmentation (Huge feature set is extracted), for feature extraction MaZda software is used. MaZda load images in the form of Windows Bitmap, DICOM and unformatted grey-scale image files with pixels intensity encoded with 8 or 16 bits. The image information header from image acquisition protocol has an option for reading details. Image normalization. The analysis is performed within these regions by defining regions of interest (ROI). There is up to 16 regions of any shape that can be defined, edited, loaded and they can also be saved as disk files. The feature set is divided into following groups: histogram-, cooccurrence matrix, run-length matrix-, gradient, autoregressive model- and Haar wavelet derived features. From the saving and loading reports into disk files used in displaying image analysis reports.

ML Model:

The best classification algorithm that able to classify large amounts of data with accuracy is Random Forests algorithm. Random Forests are an ensemble learning method for classification and regression. The number of decision trees from the mode of classes output at training time and outputting the individual trees. The basic principle is that a group of "weak learners" can come together to form a "strong learner". Because of the law of large numbers, random Forests make predictions that are considering and do not over-fit. Introducing the right kind of randomness makes them accurate classifier.

[5] The main objective of this work is to detect the early stage of DR using the features extracted from the pre-processed image. The image obtained from the database is subjected to the pre-processing steps such as green channel extraction, contrast enhancement, median filtering and histogram equalization. The disk shaped structuring element is morphologically operated from the image after preprocessing. For the removal of optic disk, connected component analysis method is used. Finally, the image is then used for feature extraction. The extraction happens from the features like Microaneurysms area, homogeneity and texture properties. The appropriate features for classification are selected. The classification of the input images as normal and DR based image by support vector machine technique. At last, by using extracted features the earlier stage of DR can be detected.

Segmentation Method:

The pre-processed image is converted to binary image by applying proper thresholding value. This binary image is subjected to morphological operations i.e., opening and closing. The dilation and opening of erosion can be defined as closing operation. In this, growing and thickening of objects in a binary image by using dilation. From the binary image, erosion shrinks or thins the objects. The process of thickening and thinning of structuring element is defined as the shape (dimension). As the optic disk and microaneurysms are circular in shape, a disk shape structuring element is used in this project and the optic disk occupies more area of the retinal image and it should be removed for facilitating the microaneurysms detection. Thus the connected component analysis method is used for the elimination of optic disk.

ML Model:

Support Vector Machine Support vector machine is a supervised learning process applied for analyzing the training data to find an optimal way to classify the diabetic retinopathy images into their respective classes namely Normal, Mild and Severe. SVM is a robust method used for data classification and regression. The given data which can be linearly separated into classes by constructing hyperplane from SVM models. The training data should be statistically sufficient. The classification parameters are formed according to the calculate features using the SVM algorithm.

III. CONCLUSION

If there is an effective method for segmenting the diabetic features in the fundus image. Then the fast and efficient early detection of Diabetic Retinopathy is possible. The proposed system presents a fast, effective and robust way of detecting diabetic features in the fundus images which can be used for classification of the images based on the severity of the disease. By using gray scale conversion, preprocessing and feature extraction steps, the retinal images are subjected. The extracted features are fed to a Fast Regional Neural Network classifier which will classify the images into different severity levels. Thus this Fast Regional Neural Network technique has given a successful DR screening method which helps to detect the disease in multiple stages.

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