REVIEW ON CLASSIFICATION METHODOLOGIES FOR ACCURATE DETECTION OF LESIONS IN DIABETIC RETINOPATHY

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ABSTRACT

Diabetic Retinopathy (DR) affects the retina where diabetic condition exists. It is not treated and identified at early stage it can soon develop decreasing vision leading to blindness, causing retinal damage. Though enormous research has been made in DR the detection of exudates still remains as a challenge for varying dataset. This paper focuses on detailed review of techniques and dataset used so far for identifying various pathologies in retina of diabetic eye. As various techniques are available to identify the pathology of the eye such as visual test, dilation of pupil, and optical coherence tomography yet these are found to be consume more time. Various techniques are used by authors to identify various pathology belonging to hard and soft exudates. The comparison results show the specificity and accuracy results obtained depending on the data set used. Detection of diabetic retinopathy is performed using various classifiers using supervised and unsupervised models such as K-Nearest Neighbor, Random Forest, gradient descent approach, Support Vector Machine and Machine learning concepts based on Neural Networks trained using deep learning techniques that has pretrained models for recognition.

Keywords—Diabetics, Exudates, Optical Coherence Tomography, Classifier, Neural Networks.

I. INTRODUCTION

Diabetic Retinopathy is visualized by the occurrence of various lesions types such as micro aneurysms, hemorrhages which appear redder and yellow colored exudates. The initial indication is micro aneurysms in retina which appear as tiny circular form. Hemorrhages may develop at severity condition when the retinal blood vessels become fragile and ruptured developing abnormality. They occur in various shapes and their appearance also differs as yellow or red patches with fluids containing protein deposits. Several segmentation and classification methods are put forth for getting a clear vision on research in DR. As initial stage of DR developed no symptoms, it is found that an automated diagnosis of DR can avoid visual damage. After identifying the presence of pathology the severity levels are graded for efficient treatment to avoid visual loss.
The above figure showed the steps involved in general detection of exudates. That involves feature extraction phase followed by classification phase where classification is achieved using suitable classifier.

II. LITERATURE SURVEY ON DETECTION TECHNIQUES

2.1. Genetic Algorithm and PSO
Karegowda et al. [1] used a network technique based on backward propagation for recognition of exudates. The feature selection was based on Genetic system that was based on correlation to extract the pathologies required for fundus image classification. A decision tree was used to take decision. Better performance was achieved using back propagation neural network. Sreejini et al. [2] discussed a methodology for automatic classification depending upon the rigorousness of Diabetic edema that was present in retinal images. Using particle swarm algorithm, pathologies were identified. Here, Optic Disc and fovea extraction was made using mathematical technique based on morphology. Later, complications of diseases were identified based on the position of exudates in a relative manner. Gargeya et al. [3] used a driven method of data for finding out the abnormality that exist in diabetic retinopathy condition performed through deep learning. Using MESSIDOR 2 and database of E-Ophtha the fundus images were tested and performance analyzed as area under the receiver operating characteristic curve was obtained with a score of 0.94 and 0.95, respectively.

2.2. SVM and Gaussian mixture model
Syed et al. [4] used a novel method for identifying Macular Edema that is present in fundus images. Certain peculiar features were used to reduce the fovea region that is much nearer to the macula. Then, using support vector machines segmentation of exudates were performed. A support vector machine based new hybrid classifier model is given as an ensemble of Gaussian mixture model to improve exudates detection. [5]. To isolate the abnormalities from fundus a approach based on threshold was used that varies dynamically was used in the images. Edge detection belonging to category of processing finally was used to distinguish hardand soft lesions also artefacts noise factors. The efficiency of algorithm is evaluated in a database consisting retinal images of varied brightness level, and quality[6].

2.3. Machine learning & DCNN method

An automated computer-aided diagnosis system was used capable of detecting both the types of exudates and distinguish from drusen that is present in color images. A diabetic patient has developed approaches to improve the retinal experts performance level. Using additional data sets, machine learning technique can be improved for identifying clinically significant lesions that are bright, thereby improving diagnosis at an early stage to avoid visual loss that occur in diabetes patients much better than that of sampling at random[7]. Yang et al. [8] used convolutional neural networks based on deep learning technique method consisting of two level to position and identify fundus images containing red lesions. This approach categorised different DR grades of fundus images. Normal, mild and intense are the label of classes of fundus images. Wang et al. [9] to obtain graded features and classify using random forest that is trained using neural networks that used convolution filter. Using, 6 convnets layers along with a subsequent sub-sampling layer, the features were extracted. DRIVE and STARE databases were used to acquire accuracy of 98.1 % and 97.2 % respectively. Complexity is increased by additional preprocessing levels through technique of deblurring prior to detection, segmentation of microvascular condition, improving light intensity using mathematical model and morphological reconstruction. To detect dark-colored lesions named as microaneurysms and haemorrhages thresholding technique along with, adaptive preprocessing was used [10,11] after that the vessels were removed set of input Structures. Using multilayer perceptron analysis vessels are identified [10] along with multiscale morphological closing operation[11]. The major drawback being misinterpretation of false positives groups were detected as lesions during segmentation process. Due to this, lesions are not properly extracted in upcoming stages for processing the blood vessels.

Here both image processing containing morphological operation and fuzzy logic technique is combined to extract exudates that are hard present in fundus images. At the initial stage, elimination of the optic disc is performed thereafter the exudates are properly identified using morphology technique. Based on fuzzy sets and membership functions, hard exudates are extracted using adaptive fuzzy approach that uses RGB color space values present in retinal image. The fuzzy outputs present in exudates are estimated for input set pertaining to RGB channels of exudate pixel[12], Sopharak et al.,[13] have used a Fuzzy Clustering Mean to identify abnormal exudates. At an initial stage, contrast enhancement technique is applied, later we obtain information from features of image to follow a coarse segmentation method based on clustering process. The features extracted are pixel intensity, curve deviation, edge pixel detection. Using the entropy feature the optic disc is identified followed by extraction of exudates. They have applied morphological reconstruction following the FCM clustering algorithm to obtain good results in segmentation. Another approach has used automatic detection of exudates used super pixel feature classification technique that has extracted numerous features. The image is first sub-divided into super pixels series which are taken as input,[14]. Out of 20 features,19 consists of intensity features which are multi-channel and a new technique is proposed for each input characteristics to which they belong. To differentiate the true exudates from the false one for multi feature technique was used for automatic recognition and prediction. The classification accuracy can be improved by designing methods to extract optic disc.

To screen the onset of non-proliferative diabetic retinopathy condition the fundus images are being processed. To extract the abnormality in retinal images, such as hard, soft exudates, and identify severity condition of hard exudates a novel preprocessing technique was used. A classifier rule is used to recognize the pathology sub-class of diabetic retinopathy into an abnormal one. Three levels exist to identify the NPDR abnormality condition which may be mild, moderate, and severity level. [15]. The performance was analysed using STARE using decision based support algorithms. Another technique has been developed for identifying microneurysms pathology that exists in images of retina for aid in DR diagnosis. A new group of about 30 retinal images which were labeled from 256 images got from MESSIDOR dataset is used for microneurysms detection using various algorithms. This algorithm was validated with as public dataset as well as labeled one to obtain best detection ratio results. Results eliminate false positive microneurysms detection obtained from the labeled. The ROC score of 0.42 for the proposed method is achieved which is better compared to existing one.[18]
To classify images containing large dataset, deep convolutional neural networks were used to classify about 1.1 million images with good resolution. The ImageNet contained the images which was categorised into 1000 different classes. It is fund that the error rates were considerably less of around 37% and 17 % which has proved to be far better than prior state-of-art. The neural network contained few convolutional layers, with quite million of parameters and large number of neurons which were passed to max-pooling layers for downsampling, and finally passed to fully-connected layers for classification hat contained activation functions. Also efficient GPU implementations with convolution operation werediscussed[19].

### III. COMPARISON OF VARIOUS TECHNIQUES TO IDENTIFY EXUDATES

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of Technique</th>
<th>Identified Pathology &amp; Dataset used</th>
<th>Technique used &amp; Results obtained</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Detection of DR on digital fundus images automatically[10]</td>
<td>Haemorrhage, microaneurysms, hard exudates. 30 retinal images were considered</td>
<td>Region growing algorithms based on segmentation were used with Moat Operator. Sensitivity was 88.5% and specificity was 99.7% for exudate detection</td>
<td>2002</td>
</tr>
<tr>
<td>2</td>
<td>Detection of exudates, and cotton soft spots in color digital fundus images for DR[7]</td>
<td>Distinguish among drusen, hard, and soft woolen spots. 300 retinal image database captured using nonmydriatic camera</td>
<td>Automated system based on Machine learning. ROC curve area has 0.947 sensitivity, and 0.88 specificity</td>
<td>2007</td>
</tr>
<tr>
<td>3</td>
<td>A Fuzzy C-means clustering automatic exudate detection from non-dilated diabetic retinopathy retinal images[13]</td>
<td>Exudates can be detected from digital image with a least contrast level in patients possessing pupils that are non-dilated.</td>
<td>Contrast enhancement Fuzzy C-Means preprocessing technique got 87.28% Sensitivity and specificity of 99.24%</td>
<td>2009</td>
</tr>
<tr>
<td>4</td>
<td>Analysis of retinal image using mixture models for hard exudate detection[6]</td>
<td>Automatic detection of hard exudates. Database taken with some retinal images of various color and brightness level.</td>
<td>Mixture models used with threshold to separate exudates &amp; based on edge detection approach. 90.2% Sensitivity and obtained positive predictive value of 96.7%</td>
<td>2009</td>
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<tr>
<td>6</td>
<td>A decision based support system for automatic screening of NPDR[15]</td>
<td>Automatic screening system of NPDR severity levels.</td>
<td>The algorithms based on decision making was used analysed using STARE database.</td>
<td>2011</td>
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<tr>
<td>7</td>
<td>Automatic Grading in the Severity level of Diabetic Macular Edema Using Color DR Images[2]</td>
<td>Severity level of diseases such as normal, and abnormality of diabetic macula edema condition is detected by the location of exudates MESSIDOR database</td>
<td>Automatic unsupervised technique was used to classify and for effective segmentation Particle Swarm Optimization of exudates was used to get 82.5% sensitivity, 100% specificity, 93% accuracy</td>
<td>2013</td>
</tr>
<tr>
<td>8</td>
<td>Grading of diabetic macula edema and exudates based on Automated detection [5]</td>
<td>Accurate detection of macula in DR. 106 images taken using non-mydriatic retinal camera.</td>
<td>An ensemble hybrid model comprising of Gaussian mixture &amp;SVM. Achieves 97.2%, 95.8% and 96.7% for sensitivity, specificity and accuracy were obtained</td>
<td>2014</td>
</tr>
<tr>
<td>9</td>
<td>Curvelet transform kernel technique using fuzzy c-means for blood vessel and optic disc removal [16]</td>
<td>Blood vessels were extracted from retinal fundus containing matched filter. Performance evaluation made on multiple public databases such as DRIVE,</td>
<td>Matched filtering, Laplacian of Gaussian, K means fuzzy logic with morphological operation. Vessel extraction accuracy of DRIVE is 96.16% and for STARE databases is 97.35%</td>
<td>2016</td>
</tr>
</tbody>
</table>
STARE & DIARETDB1

**A Deep Learning approach to identify diabetic retinopathy automatically[3]**

The color fundus were differentiated as DR and non-DR condition. The classification was analyzed using 2 publicly available databases.

Deep learning tool based on driven by data was used to achieve a significant results on publicly available databases to achieve closer to 0.95 AUC score

2017

**Blood vessel retinal segmentation category based on ensemble learning and feature [9]**

To obtain accurate retinal blood vessel segmentation. DRIVE and STARE database were used.

Neural Network based on convolution operation and Random Forest method was used. DRIVE sensitivity 0.83, accuracy 0.92 and for STARE 0.71, 0.97 was got

2017

**Grouping of macular edema Fundus images based on recognition [4]**

Identifies location of abnormalities and macula. The online datasets are DRIVE, DIARETDB1 and MESSIDOR, AFIO were used.

For detection and diagnosis a 10-fold validation technique was used. An average accuracy detection of 96.1% for grading of ME

2018

**Classification and processing based on the machine learning sensor network structure [17]**

To improve accuracy and training efficiency in image classification. Public datasets CIFAR10 and 100 dataset were preferred.

Novel sensor network used for processing accuracy of classifier using a generative adversarial network. Good accuracy was obtained on MNIST.

2019

**REFERENCES**


**IV. CONCLUSION AND DISCUSSION**

This paper presents an elaborate review on significant identification of retinal exudate pathologies that is present in diabetic retinopathy and various techniques used to improve the performance parameters like sensitivity, specificity, accuracy which can be readily determined from the confusion matrix. The authors so far has used various classifiers like SVM, fuzzy c means, and clustering techniques for classification. Recently, convolutional neural networks that has used the concept of deep learning has acquired more importance due to large dataset and training of network could automate the system and can improve the detection accuracy of neural networks. The review presented analysis of algorithms using large number of database for comparison.

Various architectures based on Visual geometry group, ResNet can be used to improve various performance metrics and can save the condition in which permanent vision loss can occur. In future transfer learning technique where by using the knowledge of a particular database, a similar type of application can be trained so very efficiently. It can gain significant attraction as it can accept and process two different sets containing pathology which differs from deep learning that can predict only one type of pathology dataset.

**REFERENCES**


