Diabetes Retinopathy Detection : A Survey

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Abstract

Diabetic Retinopathy (DR) is a disease that may cause vision impairment. The early detection of this disease is important. This work surveys the different detection and feature selection techniques involved in the detection of this disease. This can be done by studying the lesions found in the human retina using fundus images. This work also reviews the various feature extraction techniques such as Support Vector Machines, Neural Networks, and Convolutional Networks. Deep learning algorithms are discussed and the different ways of implementation of the automated system are discussed.

Keywords: Convolutional neural networks, Deep Learning, Diabetes Retinopathy, feature selection, lesions, fundus images, Neural Networks, Support Vector Machines, vision impairment.

I. INTRODUCTION

Diabetes retinopathy is a disease found in many people which may lead to vision impairment [1]. The traditional methods of detection were costly and not accurate. Hence, various automated methods are used in the detection of diabetes retinopathy [3].

There are various stages of retinopathy namely, Non-proliferative diabetic retinopathy (NPDR), which is early detection and Proliferative diabetic retinopathy (PDR), which is the advanced stage [9]. This work discusses various methods of detecting diabetes retinopathy, extracting the features, and measuring their performance. This paper also discusses various methods used for classification such as Support vector machines, Neural Networks, Adaboost [10]. The various data sets include DRIVE, STARE, Kaggle, EyePacs, Messidor, Diabeticret DB 1, and DB-reet [6].

II. LITERATURE SURVEY

A. Detecting Diabetic Retinopathy Using Deep Learning

[1] evaluates the different stages of retinopathy using automated tools. In this approach, color fundus images are used for detection.

The methods used are image classification, pattern recognition, and machine learning. Conv Net is used for training the system. The Kaggle data set is used for training and testing the system.

The dataset used in training are 10,000 images. The sensitivity, specificity, and accuracy are 75, 65, and 67 respectively. The dataset used in testing are 40,000 images. The sensitivity, specificity and accuracy are 97, 87, and 88 respectively.

B. Feature Extraction From Fundus Images for the Diagnosis of Diabetic Retinopathy

The detection of lesions in fundus images is discussed in [2]. The technique utilizes the abnormal thickness in blood vessels that helps to locate the optic disk. The images are converted into two channels say, green and red. The two filters Max and Min are used to extract the gray scales. In the proposed work, the identification of optic disks combines the blood vessels, and high disk density optic functions into a single cost function.

The dataset includes 51 images out of which 34 were affected, which in turn are segregated based on lesion type,

Manuscript Received: January 8, 2020; Revised: January 16, 2020; Accepted: January 18, 2020. Date of Publication: February 5, 2020.
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Doi:10.17010/ijcs/2020/v5/i1/151312

while 17 are unaffected. The accuracy obtained from features extracted is about 95% for micro aneurysm, 95% of sensitivity, 94% of specificity for exudates identification, and yields 97% of success rate for optic disk localization.

C. Diabetic Retinal Fundus Images: Pre-processing and Feature Extraction for Early Detection of Diabetic Retinopathy

Various techniques are deployed in [3] to pre-process the raw retinal fundus images and the features are extracted using green channel, histogram equalization, image enhancement, and resizing techniques. As a result, 14 features are extracted. Kaggle data set is used in this method. Diabetes retinopathy is classified into three classes of images namely mild, normal, and severe. The best ranked result is obtained in exudate area with a mean difference of 1,029.7.

D. Diabetic Retinopathy Using Morphological Operations and Machine Learning

A method to detect exudates and microaneurysms is proposed in [4]. It detects retinal microaneurysms and exudates for automatic screening of DR using Support Vector Machine (SVM) and KNN classifier.

For classification purpose GMM, SVM, KNN, and ADABOOST methods are used. The input image of size 2240 X 1488 pixels in .tiff format is used for pre-processing stage and then applied to segmentation method. The data set used is Messidor, Diabeticret DB 1, and DB-reet. Hence, the specificity obtained is 100% and sensitivity is more than 90% for SVM.

E. Diagnosis of Diabetic Retinopathy Based on Feature Extraction

A technique is proposed in [5] that processes the digital inputs, analyzes results, and diagnoses different retinal illnesses due to retinopathy. The features studied are micro-aneurysms, optic disc, exudates, and blood vessel.

In feature extraction, image is pre-processed, and converted into binary image. Kirsch's non-linear edge detector is used to search the maximum edge in a few determined directions.

From analysis and experiment, the pixel count for candidate microaneurysm ranges from 30 to 5,000 pixels for a 1320x1024 image.

Dataset used are DRIVE database and STARE database.

F. Detection of Blood Vessels in Retinal Images Using Two-dimensional Matched Filters.

Roychowdhury, Koozekanani, and Parhi [6] designed a system to detect blood vessels in the retinal images. The Gaussian shaped curve is obtained by gray level profile. For searching the vessel segments 12 templates were constructed.

The fundus angiogram image (170x200~8) is taken for analysis. The proposed algorithm is implemented using MATLAB. This algorithm finds the green and red vessels. Revascularization can be found using mass screening of data.

G. Detection of Hard Exudates in Color Fundus Images of the Human Retina.

In [7], a method is proposed to detect hard exudates from color fundus images collected.

The different steps include pre-processing stage followed by contextual clustering algorithms that have been applied to segmented exudates. Features taken for classification are standard deviation, mean, intensity, edge strength, and compactness of the segmented regions. Echo State Neural Network (ESNN) is used to discriminate between normal and pathological image.

A total of 50 images are chosen out of which 35 images are used for training the model and 15 are used for testing. The outcomes are in the range of 93.0% sensitivity and 100% specificity in terms of exudates-based classification.

H. DREAM: Diabetic Retinopathy Analysis Using Machine Learning

Gargeya and Leng [8] designed a computer-aided screening system (DREAM) which analyses fundus images with varying illumination and fields of view and generates a severity grade for diabetic retinopathy (DR) using machine learning.

The Classification techniques such as the Gaussian Mixture model (GMM), k-nearest neighbour (kNN), support vector machine (SVM), and AdaBoost are used. GMM and kNN classifiers are found to be the best classifiers for bright and red lesion classification.

The features are ranked using Adaboost algorithm. It used MESSIDOR dataset that includes 1,200 images.

The results were 100% sensitivity, 53.16% specificity, and 0.904 AUC compared to the best reported

96% sensitivity, 51% specificity, and 0.875 AUC, for classifying images as with or without DR. The feature reduction further reduces the average computation time for DR severity per image from 59.54 to 3.46 s.

I. Automated Identification of Diabetic Retinopathy Using Deep Learning

Gulshan, Peng, Coram, Stumpe, Wu, Narayanaswamy, and Kim [9] developed a data-driven deep learning algorithm for automated diabetes retinopathy detection.

The processing of color fundus images is done followed by classification of healthy and affected fundus images.

The data set included 75,137 publicly available fundus images from diabetic patients that were used to train and test the model and used E-Ophtha and MESSIDOR 2 databases for validation.

In order to measure the prediction, the receiver operating characteristic curve (AUC) is used and 5-fold cross-validation is used in local data sets. The AUC score of 0.94 and 0.95 is achieved in testing the databases such as MESSIDOR 2 and E-Ophtha.

J. Diabetic Retinopathy Classification

Sivakumar, Ravindran, Muthayya, Lakshminarayanan, and Velmurughendran [10] proposed a system to classify different types of retinopathy and monitor the changes that are done by the automated computer model in a virtualized environment.

It uses 3D max studio for animation of signals and Widows Movie maker for implementation. The patterns are recorded with a checkerboard screen and then converted into X-Y components. The signals were identified using the MATLAB signal with 9.5% confidence level.

The amplitude of frequency for normal patients is 7Hz and for diabetic retinopathy patients, frequency is 3Hz to 4Hz. For normal patients peak frequency is at 7Hz and for pre-proliferative diabetic retinopathy and proliferative diabetic retinopathy patients, the peak frequency is 5 Hz to 6 Hz.

The voice signals along with the animated picture are used in the treatment of diabetes retinopathy.

K. A Hybrid Deep Learning Model for Detecting Diabetic Retinopathy

Seth and Agarwal [11] proposed a hybrid deep learning technique for detecting diabetes retinopathy in fundus images.

The techniques employed are convolutional neural networks and linear support vector machines to train the network. The data set used is EyePACS. The sensitivity and specificity for the model with linear network constitutes 0.93 and 0.58, whereas softmax includes sensitivity and specificity as 0.87 and 0.67 respectively.

L. Classifying Diabetic Retinopathy Using Deep Learning Architecture

Chandrakumar and Kathirvel [12] propounded a deep learning approach for diabetic retinopathy detection. The technique used is a complex Deep Convolutional Neural Network (DCNN) which gives high accuracy on classification. The classification of different types of retinopathy stages are identified using this model. It uses supervised learning algorithms to classify the fundus images. The datasets used are STARE, DRIVE, and Kaggle. The accuracy obtained is in the range of 94-96%. Fig. 1. shows diabetic retinopathy.

III. CONCLUSION

This survey paper depicts the various methods of implementing Diabetic Retinopathy detection and its performance is compared between various classifiers used such as Support vector machines, Neural networks, Naïve Bayes classifiers etc. and the performance variations are found on using various datasets such as MESSIDOR 2, Kaggle, STRIVE, DRIVE, EyePacs, DIARETDB0 etc.

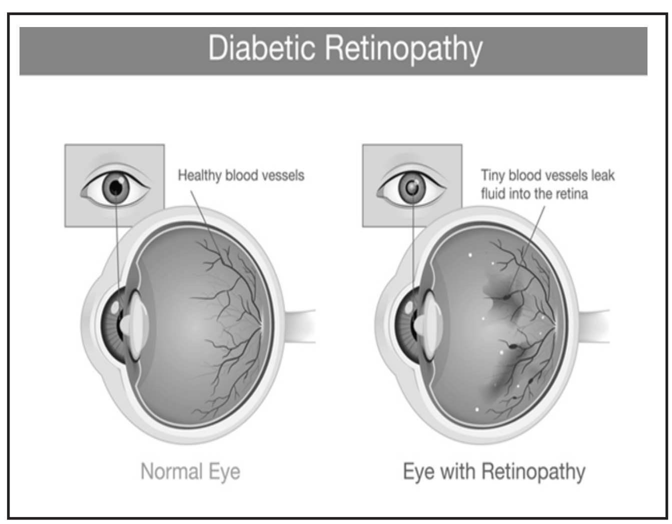

Fig. 1. Diabetes Retinopathy

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