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Diabetic Retinopathy Grading System Using Machine Learning

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Abstract : *This paper presents a system that analyzes fundus images and generates a severity grade for diabetic retinopathy (DR) using machine learning. Diabetic Retinopathy (DR) is also known as diabetic eye disease, which is the damage occurs to the retina due to diabetes. It can eventually leads to blindness. So the early detection of disease is needed. Manual detection is time consuming and often make observation error. Hence several computer-aided systems are introduced and which would make fast and consistent diagnosis-aid useful for biomedical and health informatics field. Here a system is proposed in which AdaBoost classifier is used for classifying retinopathy lesions from nonlesions.*

Keywords - *Diabetic Retinopathy, Feature extraction, Classification, Segmentation, Bright lesion, Red lesions.*

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I. Introduction

Diabetic retinopathy (DR) is a condition that happens in those who have diabetes. It causes progressive damage to the retina, the light-sensitive lining at the back of the eye. Diabetic retinopathy is a serious sight-threatening complication of diabetes. The disease is characterized by an excessive amount of sugar in the blood, which might cause damage throughout the body, together with the eyes. Over time, diabetes damages the blood vessels within the retina. Diabetic retinopathy happens when these tiny blood vessels leak blood and other fluids. This causes the retinal tissue to swell, leading to cloudy or blurred vision. The condition typically affects each eyes. The longer a person has diabetes, the more likely they will develop diabetic retinopathy. If left untreated, diabetic retinopathy will cause blindness [1].

A study done by the American Diabetes Association (ADA) describes that diabetic retinopathy (DR) had affected quite 4.4 million Americans, and nearly 0.7 million people those with diabetes having advanced DR that would result in severe vision loss [1]. Diabetic Retinopathy (DR) could be a common complication of diabetes, ensuing from chronic damage to blood vessels within the retina. Since early identification and treatment of DR has been clinically well-tried to reduce the possibilities of severe vision loss by 90%, early identification is very imperative for enhancing the resourcefulness of present day eye-care. The purpose of this paper is to propose a fast and accurate system which grade the severity of diabetic retinopathy from retinal fundus images. There are several diabetic retinopathy screening systems are existed, in which classifiers such as the Gaussian Mixture model (GMM), k-nearest neighbor (kNN), support vector machine (SVM), are analyzed for classifying retinopathy lesions from nonlesions. The main contribution of this paper is to generate the severity of DR from the retinal fundus images by using Machine learning. Machine learning means learning from experience, which means that teaches the computers to do what comes naturally to human. Several classification techniques are exist in machine learning, from which this paper proposes a system to use the AdaBoost classifier [2].

This paper organized as follows: Section I contains complete description about this paper, Section II includes the details of proposed method, Section III describes the conclusion.

II. Proposed Method

This is a computer aided screening system to generate the severity grade of Diabetic Retinopathy (DR), mainly consist of 3 stages: Image segmentation, Image classification and DR severity grading. The block diagram of this system is shown in Fig. 2.1.

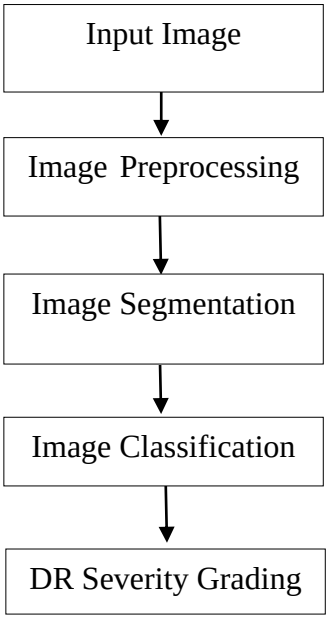

Fig. 2.1 Proposed System

The input image is the retinal fundus images. The preprocessing of the image is done before doing segmentation. After the preprocessing of fundus image, which is segmented into foreground and background regions. Optic disc & Blood vessels are included in the background regions and Bright regions & Red regions are included in the foreground regions.

It is imperative to mask out the regions corresponding to the optic disc (OD) and major portions of the blood vasculature. This is important since a bright OD may otherwise be mistaken for a bright lesion, and the vasculature can be falsely detected as a red lesion in subsequent automated stages if not masked out in the early stage [3]. Only the foreground regions classified in the classification stage. Image classification stage is a 2-step hierarchical classification, which means it first classifies the bright and red regions into lesions and nonlesions and then these lesions are again classified to corresponding subclasses. That means Bright regions are classified as lesions and nonlesions and these lesions are classified into Cotton Wool Spots (CWS), Hard Exudates (HE). As like red regions are classified into lesions and nonlesions and these lesions are classified into Microaneurysms (MA) and Hemorrhages (HA). For the image classification process several features (Area, Orientation, Solidity, Major axis length, Minor axis length, Eccentricity, etc.) are extracted and AdaBoost classifier is used. AdaBoost is called adaptive because it uses multiple iterations to generate a single composite strong learner. During each round of training, a new weak learner is added to the ensemble and a weighting vector is adjusted to focus on examples that were misclassified in previous rounds. The result is a classifier that has higher accuracy than the weak learners classifiers [4]. The DR severity is measured based on the number of Microaneurysms and Hemorrhages. In this system, four level of grades are generating, Grade 0 (No DR), Grade 1 (Mild DR), Grade 2 (Moderate DR), Grade 3 (Severe DR) [2]. These grading is measured based on the conditions in the Table 2.1.

Table 2.1. DR Severity Grading

Grade	Description
0	(MA = 0) and (HA = 0)
1	(0 < MA <= 5) and (HA = 0)
2	(5 < MA <= 15) or (0 < HA < 5)
3	(MA >= 15) or (HA >= 5)

The metrics used for analyzing the performance of the system by using this classifier can be defined in terms of true positives (TP), true negatives (TN), false positives (FP), and false negatives (FN) as follows:

Sensitivity (SEN) = $\frac{TP}{TP+FN}$ (1)

Specificity (SPEC) = $\frac{TN}{TN+FP}$ (2)

Accuracy (ACC) = $\frac{TP+TN}{TP+TN+FP+FN}$ (3)

III. Conclusion

Diabetic retinopathy (DR) is a serious disease that originates from diabetes and is the most typical reason for visual impairment in the developed countries. Early treatment will prevent patients to become affected from this condition or at least the progression of DR is delayed. The mass screening of patients suffering from diabetes is highly desired, but manual grading is slow and resource demanding. So this proposed work is focused to make a computer-aided diabetic retinopathy screening system to grade the severity grade of DR from the retinal fundus images. By evaluating the performance of this system using AdaBoost classifier in terms of factors such as Sensitivity, Specificity and Accuracy, it can be found that AdaBoost will be much better than that of other classifiers. This proposed system has wide range of use in the biomedical and health informatics field.

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