Programmed Recognition of Diabetic Retinopathy Utilizing SVM Technique

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***Abstract*- Diabetic Retinopathy (DR) is an eye disease which is caused due to increase of sugar levels in the blood of the human. It is the type of disease that mainly affects the retina of the eye which could further lead to partial or even complete loss of visual capacity. In this paper, an approach is made to identify the presence of the diabetic retinopathy from the color fundus images of the retina. This disease can be easily diagnosed through regular screenings. Using SVM technique (Support Vector Machine technique) we are able to classify the eye into normal eye, non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR), which will further reduce the review for the doctors. The automatic detection will help to screen and diagnose the disease from time to time. The main aim of our project is to give an automated, appropriate and refined approach utilizing image processing, data mining technique and pattern recognition so that DR can be easily detected at early stages and damage to the retina can be completely minimized. This therapy includes the scanned results of the fundus retinal image. Manual examinations that are generated by ophthalmologist differ from each other.**

***Keywords* - Diabetic Retinopathy, Microaneurysms, Fundus Image, SVM Technique and Data Mining Technique.**

I. INTRODUCTION

One of the complications caused by the diabetes is Diabetic Retinopathy (DR). DR is an eye disease that mainly affects the retina, which is inner coat of the eye which is a light-sensitive layer of tissue. DR is caused due to high sugar levels present in the blood vessels of the retina. These blood vessels when ruptured or broken will lead the fluid to leak into the vitreous humour. Exudates are the lesions or the dark patches that are created due to leak in the blood vessels. Microaneurysms are the swellings present inside or at the end of blood vessels. These all combined may further lead to partial or sometimes complete loss of vision, if ignored or left undiagnosed at the initial stages. Retinal lesions such as exudates and microaneurysms associated with diabetes are used to evaluate different stages and the severity of this disease. Microaneurysms are among the earliest signs of DR that arise due to high sugar levels in the blood. DR is the leading cause for poor vision and blindness. Basically there are two types of diabetic retinopathy; they are Proliferative Diabetic Retinopathy and Non-Proliferative Diabetic Retinopathy. According to recent clinical test results it was found that, early detection and treatment may prevent more than 95% of the vision reductions that are observed in diabetic patients.

Approximately 10% of patients are diagnosed to have diabetes with vision problems. Diabetic retinopathy also known as diabetic eye disease, DR is a medical condition in which damage occurs to the retina due to diabetes and leads to cause complete blindness for people aged 20 to 64 years. The longer a person has diabetes higher are the chances of his or her chances of developing diabetic retinopathy. DR can be prevented by constant check-up and screening activities.The human eye is an organ that reacts to light and has many purposes. Rods and Cones cells in the retina allow light perception and vision including color differentiation. The Fundus Image Analysis system described in this paper is developed to assist ophthalmologist's diagnosis by providing second opinion and also functions as an automatic tool for the mass screening of diabetic retinopathy. Color fundus images are used by ophthalmologists to study eye diseases like diabetic retinopathy, age-related macular degeneration (AMD) and Retinopathy of pre-maturity (ROP). Extraction of the normal features like optic disk, fovea and blood vessels and abnormal features like exudates, cotton wool spots, microaneurysms (MA) and hemorrhages from color fundus images are used in fundus image analysis system for comprehensive analysis and grading of diabetic retinopathy. Laser therapy is one of the therapies for patients with DR.

1.1 Existing system

A retinal scan of each patient is done using an ophthalmoscope to generate a retinal image, which can later be used to diagnose retinopathy. The retinal images are given to a group of ophthalmologists who manually diagnose the images and provide results within several hours which eventually leads to delayed treatment. This might take almost several months to manually analyze.

1.2 Problem Statement

Testing of the disease Diabetic Retinopathy is done manually by some trained professionals in real life which is quite time consuming process and usually leads to miscommunication and delayed results eventually leading to delayed treatment and ignorance. Lack of a automated system that provides quick and precised screening reports of retina.

1.3 Motivation

It is seen that large number of population is suffering from the disease but still testing is done manually by trained professionals in real life which is quite time taking consuming process and usually miscommunication and delayed results eventually leads to delayed treatment and ignorance. Annual screening for diabetic retinopathy in patients with diabetes could be cost effective. This technique could offer an instant hardcopy image of retina and detect sight threatening retinopathy adequately. Since the patients suffering are generally symptom free, a preventive treatment should be established for early detection

II. PROPOSED SYSTEM

2.1 Technique Used

Support Vector Machine: Support Vector Machine model is used to represent the features as points in space, then are mapped such that the features of the separate categories will be divided by a clear gap. Support vector machine is one of the supervised learning processes which are used for analyzing the data present in a particular image. Also used to find an optimal way to classify the fundus images into their respective classes namely Normal, Non-Proliferative DR and Proliferative DR. Other features are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall into. Using SVM classifier the accuracy level increases due to the techniques used for extraction and classification. SVM is a robust method used for data classification and regression. For nonlinear classification of the given data, SVM uses a nonlinear kernel function to map the data onto a high dimensional feature space where it can be linearly classified.

2.2 Software Tools Used

These images are tested on an Intel i3 PC using the MATLAB R2016b software. For hardware implementation, MATLAB, Simulink and System Generator software components are used. Basically MATLAB stands for "MATrix LABoratory". It is developed by MathWorks®. It is a high level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. Simulink basically means simulation and link which is a graphical extension to MATLAB that is mainly used for modeling and simulation of the systems. In Simulink, systems are drawn on screen as block diagrams and the proposed algorithm hardly takes a few seconds for execution of the algorithm.

2.3 Methodology

The main objective of this project work is to detect the early stage of DR using the features extracted from the preprocessed image. The proposed method mainly consists of three fundamental parts, (1) Pre-processing, which involves obtaining of an gray image from green channel, background normalization, contrast enhancement and image binarization (2) Feature extraction of the microaneurysms based on circularity, area and other features and (3) Classification based on count of MA's[1]. The image obtained from the database is subjected to the preprocessing steps such as green channel extraction, contrast enhancement, median filtering and histogram equalization. After preprocessing, the image is morphologically operated by a disk shaped structuring element. Connected component analysis method is used for the removal of optic disk. This image is then utilized for feature extraction. The features like microaneurysms area, homogeneity and texture properties are extracted. The appropriate features for the classification are selected. Support Vector Machine technique is used for classifying the input images as normal and DR based image as well as detecting the earlier stage of DR using the extracted features.

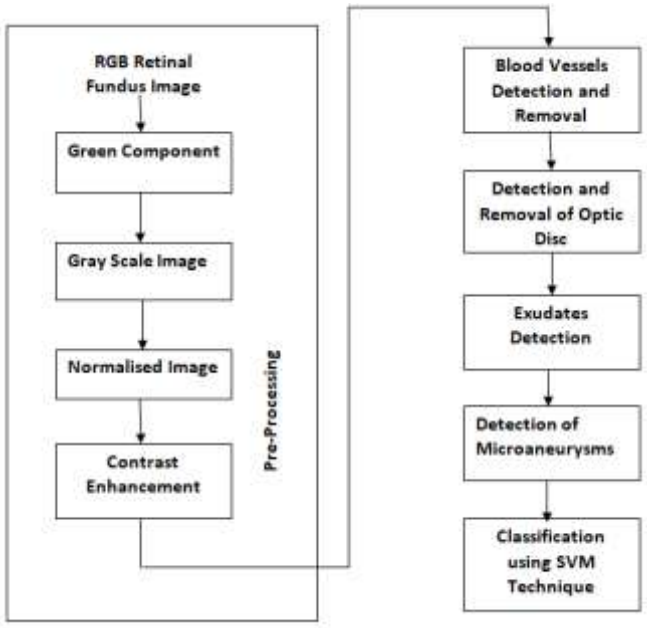

Fig 1: Proposed Methodology

(1) Pre-processing: The main aim of pre-processing is to attenuate the noise present in the image, to improve the contrast and predominantly correct the non-uniform illumination [2].

Step 1: In the RGB images, the green channel exhibits the best contrast between the vessels and background while the red and blue tend to have more noise when compared to green. Hence green channel is used for processing[2].

Step 2: The next step is to convert green channel image into a gray scale image, as the retinal blood vessels appear darker in the gray image. All the features like blood vessels, microaneurysms etc, are hidden in the background and are not clearly visible.

Step 3&4: Normalization and contrast enhancement is done to improve the image quality. Normalization is performed by

subtracting an approximate background from the gray image. Adaptive Histogram Equalization is applied for contrast enhancement. A dark region including vessels, MAs and noise are dominant after contrast enhancement. Now the output image is ready for feature extraction[4].

(2) Feature Extraction: Objective of Feature Extraction is to select all Microaneurysms present in the pre-processed image. Microaneurysms appear as isolated patterns and are disconnected from the vessels. The features of microaneurysms can be extracted based on shape, size and intensity level. After the image is pre-processed, the candidate microaneurysms are segmented by separating them from the blood vessels. Blood vessels are large in area and are connected components, thus can be identified from MA based on area. Threshold value is decided by experimentation. To remove blood vessels, objects having area greater than threshold value are eliminated. The image might include microaneurysms and some noise which are bifurcated blood vessels and other particles in fundus image. Microaneurysms are dark reddish in color, they appear as small red dots that are of 10 to 100 microns diameter and are circular in shape, and hence MAs can be identified from the noise based on area [3]. The threshold values are then decided by experimentation to remove noise objects having area which is greater and lower than MAs.

Exudates Detection and its count: Exudate is a fluid with a high content of protein and cellular debris that has escaped from blood vessels and has been deposited in tissues or on the tissue surfaces of blood vessels or in the vitreous humor, which usually results in inflammation.

(3) Classification using SVM: After the detection of Microaneurysms, classification groups the eye images as either diseased or normal depending on the count of detected microaneurysms. Classification is made using SVM technique based on the grade. The DR can be classified into four different stages as normal retina, mild DR, moderate DR or NPDR, and severe DR or PDR as shown in the following Table. [2]

Table 1: Grading of Diabetic Retinopathy

DR Stage	
Grade 0 (No DR)	MA=0
Grade 1 (Mild)	1<MA<5
Grade 2 (Moderate)	5<MA<15
Grade 3 (Severe)	MA>15

MA - Microaneurysms

III. RESULTS

The proposed automatic system takes merely a few seconds for execution and determining if the patient has diabetic retinopathy or not. The microaneurysms are detected by the algorithm. The actual microaneurysms present in the images and grading is done based on count of detected microaneurysms and exudates.

IV. CONCLUSIONS

Microaneurysms segmentation is automatically done by using mathematical morphology. The system intends to help the diabetic retinopathy screening process algorithm could detect exudates on very is 86% and 89% respectively. There are some incorrect exudate too small exudates, too blurred exudates, there are some missing exudates located next to or nearby blood vessels which are removed since they could be wrongly detected as blood vessels. Faint blood vessels can be incorrectly detected as exudates. A main weakness of algorithm depends on white pixels which can be further necessity of improving the added to the system in order to increase its ability to verify the degree of diabetic retinopathy. Sensitivity and the Specificity of various grades of images were calculated.

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