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Diabetic Retinopathy Classification using SVM Classifier

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ABSTRACT

The common cause of blindness is diabetes nowadays in working age populations. Many patients eyesight can be affected due to diabetes. People do not know the cause of blindness due to diabetes and are also unaware about different diseases caused by diabetes. Patients can suffer from dieses like cataract, glaucoma, bleeding of blood vessels, etc. Any damage caused to the blood vessels in the eye due to diabetes is called as diabetic retinopathy. Diabetic retinopathy is a micro vascular complication which can cause several changes in the retina. There are many changes which can occur like change in the diameter of blood vessels, growth of new blood vessels, micro aneurysms, hemorrhage, exudates, etc. These changes must be detected at an early stage. Diabetic macular edema (DME) is a complication of DR. DME is defined as swelling of the eye retina in diabetic patients due to leakage of fluid within the central macula from the dilated small blood vessels. LASER therapy is one of the common therapies for patients but this technology uses manual examination of scanned results and the results can differ. So to overcome this problem a special program is needed to analyze the different part of the eye. This paper proposes a special detection technique for analyzing the images of the eye. It includes preprocessing of the eye image then the image will be resized and converted into a grey scale image. Then with the help of feature extraction various parameters will be operated and images having different features will be stored to data base. Based on which the new images will be analyzed and compared so as to detect the exact problem the patient is suffering. This paper also discusses diagnosis of DME using features based on color, wavelet decomposition and automatic lesion segmentation.

Keywords: Diabetics, SVM, Automatic diagnosis, Lesion, DR

1. INTRODUCTION

An abnormality which increases the glucose level in the blood and causes damage to the blood vessels is known as diabetes [1]. Diabetes is a dangerous disease which can affect different organs of the body like nervous system, kidneys, heart, lungs, eyes etc. [2]. When diabetes damage blood vessels in the retina of the eye then diabetic retinopathy occurs. Diabetic retinopathy is a critical eye disease which damages the blood vessels in the retina and causes blindness. The blood vessel will leak blood on the retina, forming different chronic diseases or problems. It can lead to micro aneurysms, hemorrhages, hard exudates, cotton wool spots, venous loops, etc. Exudates are primary signs of DR. Hemorrhages occur when retinal blood vessels ruptures and blood escapes. Micro aneurysms appear as small round dark red dots. Micro aneurysms are focal dilatations of retinal capillaries [3].

Diabetes is a disease which is caused by abnormal increase of the glucose level in the blood. By the increased glucose level the blood vessels are damaged in the retina of the eye. Diabetes is the fifth deadliest disease in the USA. The increased rate of diabetes is one of the biggest challenges of the entire health care system. The rate of people who are affected with this disease continues to grow very fast. A huge amount of income has been spent by patients for curing this disease.

Diabetes is a disorder that occurs when the pancreas does not secrete enough insulin. Diabetes affects many parts of the human body. It's a life threatening disease and it can affect the circulatory system, the nervous system, kidneys, heart, lungs, eyes, etc. If the eye sight becomes blur, distorted or any damage caused to the tiny blood vessels inside the eye, then such a disorder is known as Diabetic retinopathy (DR). Early detection is very important to prevent blindness [4]. Detection can be done by pupil dilation using a chemical solution which affects patients and also takes time. These methods can be changed and overcome by ophthalmologists by detecting different stages of DR using bio microscopy. In this method image processing and support vector machine (SVM) techniques are used for automatic detection and diagnosis of eye health.

In this paper, a system has been designed to detect the blood vessels by using image processing techniques. Feature

extraction is done based on various parameters and feature classification has been done using support vector machine techniques so as to classify and identify the severity of the chronic disorder caused by diabetic retinopathy.
The paper is organized as follows; Section 2 discusses the literature survey of various papers in the field of Diabetic Retinopathy. Section 3 explains the research methodology. Results and discussion on results are presented in Section 4 and Section 5 concludes the paper.

2. LITERATURE SURVEY

In [1] a brief discussion about the different stages of Diabetic Retinopathy has been done. It has been stated that DR can be classified into four stages namely these four stages are Mild non-proliferative retinopathy, Moderate non-proliferative retinopathy, Severe non-proliferative retinopathy & Proliferative retinopathy. An image is analyzed by using image processing technique and support vector machine (SVM) techniques. From the raw image four features were extracted by using image processing technique and given to SVM classifier for classification of the image and it was observed that by using such an automated system accuracy of around 82% has been achieved.

In [2] an introduction about diabetic retinopathy has been done. Classification of DR has been done by using Higher Order Spectra (HOS) as feature extraction and SVM classifier. It has been concluded that the accuracy depends upon several factors such as size, quality and rigor of training set. It also depends upon the parameters chosen to represent the input.

In [3] exudates are explained and a system has been proposed which automatically detects DR exudates by using mathematical morphology methods. Detection of exudates is done from non-dilated retinal images. The proposed system investigates a set of morphological steps to automatically detect optic disc and exudates from diabetic retinopathy patients. It helps the ophthalmologists in the screening process for detecting the symptoms easily and fast. In this paper exudate detection technique based on mathematical morphology for low quality images has been proposed which can be remotely accessed on any poor computer system where expert ophthalmologists are rarely available.

In [4] the current status of diabetic retinopathy has been discussed. The causes and effects of diabetes and DR have been discussed. The different types of DR have been discussed. The different feature extraction methods and detection methods has been briefly explained. An ophthalmoscope has been used by an ophthalmologist to detect, analyze and visualize the tiny blood vessels and the different DR stages. A system has been proposed where digital images are taken and analyzed after this screening and DR detection is done using an automated system and few algorithms.

In [5] study levels of early treatment DR have been discussed. Diabetes is a common cause to blindness which leads to DR. Prevention of Diabetic retinopathy has been discussed. The two types of prevention discussed here are primary prevention and secondary prevention. Certain factors that affect or influence diabetic related complications are duration of disease, metabolic control, hypertension, family history, hyperlipidemia, smoking and puberty.

In [6] discussion on two lesions is done i.e. bright lesion and dark lesion. To detect the presence of bright and dark lesions mathematical morphology, estimation of background, analysis of color and filtering is done. Results are obtained and classification is done using SVM. The results obtained for different parameters shows performance of SVM to be excellent.

In [7] an automatic detection of DME is done using three aspects which are datasets, exudate segmentation and DME diagnosis. The different types of complied dataset are summarized and the techniques employed for automatic DME diagnosis are discussed. Results are shown and a comparative study has been done based on various parameters.

3. RESEARCH METHODOLOGY

This research has been done based on the proposed system

3.1 Proposed system for classification of different stages of DR

The proposed system for classification of different stages of Diabetic Retinopathy is as shown in Fig. 1. The database is the first block where the images are stored. An image is taken from the database and this image is pre-processed using various image processing techniques. After image processing feature extraction process starts. In feature extraction process the different features are extracted from the image. This image is now sent to the feature classifier where classification is done and based on this process the output is classified. The output is classified further into five different categories.

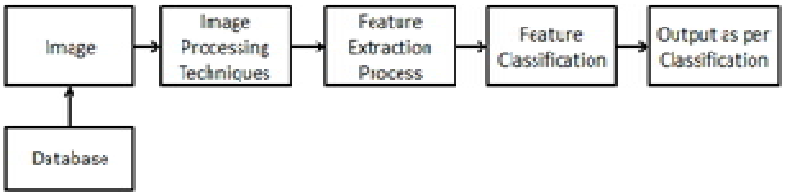

Fig. 1. Proposed system for classification of different stages of Diabetic Retinopathy

3.2 Processes used in the proposed system for classification of different stages of DR

Image processing: Images are taken from a camera in JPEG format and the image size is about 256 x 256 pixels and stored in database. Now images will be taken from this database. Using image processing techniques the images can be pre-processed to obtain various parameters.

Feature Extraction: Extraction of features is done on the parameters like blood vessels, exudates, micro aneurysms, and hemorrhages. To obtain the traces of the blood vessels the green channel of fundus RGB image has been used. In image processing the background is smoothened. Filtering is done using median filter to remove noise. A border has been created to extract blood vessels around the image. The intensity values of the image are subtracted from the image to eliminate edges. Then the pixel values are inverted to obtain the final image with only traces of blood vessels. Detection of exudates is done by obtaining two structural elements i.e. disc shaped and octagon shaped by comparing with the background the detection can be done. Detection of blood vessels with hemorrhage can be done by enhancing the intensity of the image by using large structural elements. Then the original image is dilated and subtracted from the enhanced image. This image is filtered using wiener and median filter. The optical discs are removed from the image and now the image shows hemorrhages. The process is same in micro aneurysms at the end the image will be subtracted with the edge detected micro aneurysms image.

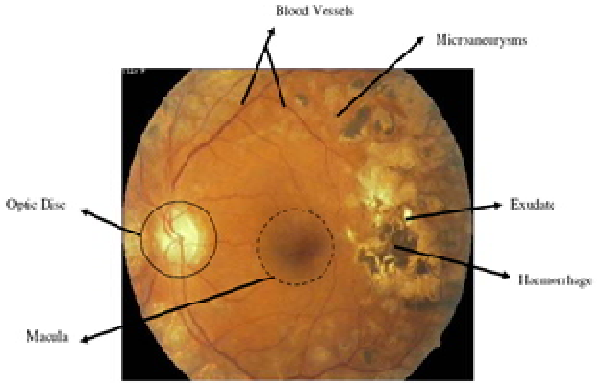

Fig. 2. Different features in a DR image [4]

Feature Classification: The feature classification has been done using SVM classifier. SVM classifiers have shown excellent performance in the field of pattern recognition. Finally the image is classified into five categories: Normal image, mild non-proliferative retinopathy, moderate non-proliferative retinopathy, severe non-proliferative retinopathy & proliferative retinopathy.

In [6] the process used to classify the image is shown in stages. These stages are as follows in Table 1.

Table: 1 Process to classify image

Table 1: Process to classify image

1	Retinal Fundus Image Acquisition
2	Converting RGB to Gray scale
3	Eliminating Blood vessels in
4	Optic Disk detection and
5	Dark and bright Lesion

Initially there is a preprocessing that has been done. In preprocessing image acquisition is done in which input data is included this image is reduced to half size of the original image. Then the image is converted into gray scale image to get dark lesion and entropy values

$$Entropy = \sum_{i,j=0}^{N-1} p(i, j)(-\ln p(i, j))$$

Eliminating the blood vessel in the eye. In this process a dilation is done and after this process erosion is done. In the next process disk detection is done after that removal of exudate is done for separating light features from dark features.

4. RESULTS & DISCUSSION

Fig. 3 shows results of detection of tiny blood vessels for normal, mild non-proliferative retinopathy, moderate non-proliferative retinopathy, severe non-proliferative retinopathy & proliferative retinopathy. Many results of detection for micro aneurysms, hemorrhages, hard exudates, cotton wool spots, venous loops, etc. can be detected. For these results classification of severity of DR can be detected and based on that further treatment can be recommended.

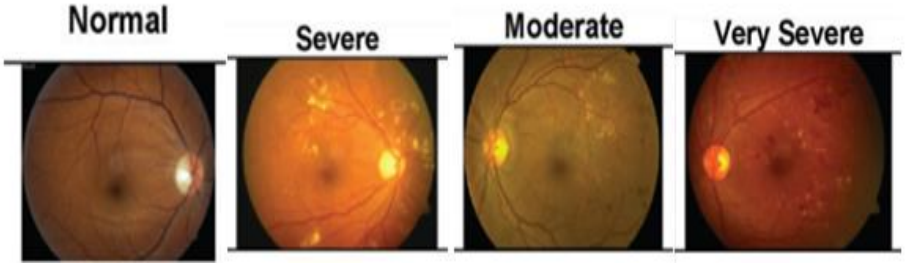

Fig. 3. Figure shows the detection of tiny blood vessels for normal, mild non-proliferative retinopathy, moderate non-proliferative retinopathy, severe non-proliferative retinopathy & proliferative retinopathy [4]

5. CONCLUSION

An automated system has been proposed to classify the DR stages using image processing technique and feature classifier. Here different methods for feature extraction have been discussed. This system can be used for detecting the appearance of the disease and if it occurs it can also detect up to what extend is its severity. By doing this the patient health can be monitored and the progress and response to treatment can be observed. This system also reduces the cost and makes the screening of the eye easy..

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