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# Automatic Prediction of Retinal Diseases using Image Processing Techniques

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***Abstract - Retina is a thin layer present behind the eye which is connected to the brain through optic nerve and it is responsible for the visualization. Retinal disease is the most frequent cause of blindness for working age population. Diabetes has become a new global challenge. If not diagnosed and treated in time, diabetes can encourage illness related to the retina of human eyes that affects the retina and retinal structure in certain ways. The detection of such abnormalities in the retina is called Diabetic Retinopathy (DR). Diabetic retinopathy is classified into two categories, non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR). Age related macular degeneration (AMD) is common cause of irreversible loss of central vision in elders. These two diseases are the most common cause for the vision loss. Early detection helps the patients to aware of the seriousness of the disease and prevents the blindness. This paper uses the process and knowledge of image processing to automatically predict DR and AMD from fundus images of retina. The Pre-Processing stage equalizes the uneven lighting associated with fundus images and removes noise present in the image. Segmentation stage partitions the image and converts it into required form for feature extraction. Feature extraction stage extracts the various features from pre-processed and segmented fundus image. In classification stage, the retinal diseases are classified as Normal, AMD, and DR (NPDR or PDR).***

***Keywords- Retina, Retinal Diseases, Diabetic Retinopathy, Age related macular degeneration, prediction, image processing.***

## I.INTRODUCTION

The Retina is a thin layer of tissue on the inside back of the eye. The retina contains millions of light-sensitive cells (rods and cones) and other nerve cells that receive and organize visual information and sends this information to the brain through optic nerve, enabling you to see.

Retinal diseases vary widely, but most of them cause visual symptoms. Retinal diseases can affect any part of your retina Treatment is available for some retinal diseases. Depending on your condition, treatment goals may be to stop or slow the disease and preserve, improve or restore your vision. Untreated, some retinal diseases can cause severe vision loss or blindness. Therefore early prediction of retinal diseases is important.

Common retinal diseases and conditions include:

**Retinal tear:** A retinal tear occurs when the clear, gel-like substance in the center of eye (vitreous) shrinks and tugs on the thin layer of tissue lining the back of eye (retina) with enough traction to cause a break in the tissue. It's often accompanied by the sudden onset of symptoms such as floaters and flashing lights.

**Retinal detachment:** A retinal detachment is defined by the presence of fluid under the retina. This usually occurs when fluid passes through a retinal tear, causing the retina to lift away from the underlying tissue layers.

**Diabetic retinopathy:** If you have diabetes, the tiny blood vessels (capillaries) in the back of your eye can deteriorate and leak fluid into and under the retina. This causes the retina to swell, which may blur or distort your vision. Or you may develop new, abnormal capillaries that break and bleed. This also worsens your vision.

**Epiretinal membrane:** Epiretinal membrane is a delicate tissue-like scar or membrane that looks like crinkled cellophane lying on top of the retina. This membrane pulls up on the retina, which distorts vision. Objects may appear blurred or crooked.

**Macular hole:** A macular hole is a small defect in the center of the retina at the back of the eye (macula). The hole may develop from abnormal traction between the retina and the vitreous, or it may follow an injury to the eye.

**Macular degeneration:** In macular degeneration, the center of the retina begins to deteriorate. This causes symptoms such as blurred central vision or a blind spot in the center of the visual field. There are two types — wet macular degeneration and dry macular degeneration. Many people will first have the dry form, which can progress to the wet form in one or both eyes.

**Retinitis pigmentosa:** Retinitis pigmentosa is a degenerative disease that affects the retina.

The two major retinal diseases are Diabetic retinopathy (DR) and age-related macular degeneration (AMD) which causes blindness and vision loss.

Diabetic retinopathy - The diabetic retinopathy is one of the leading problems for diabetic patients. Diabetes is a disease which occurs when the pancreas does not secrete enough insulin or the body is unable to process it properly. After 15 years of diabetes about 10% of people become blind and approximately 2% develop severe visual impairment. According to an estimate by World Health Organization (WHO), more than 400 million people worldwide have diabetes [2]. It is the largest cause of blindness among the people of working age in India, making it the world's diabetic capital. As diabetes progresses, the disease slowly affects the circulatory system including the retina and occurs as a result of long term damage to the blood vessels, deteriorating the vision of the patient which leads to diabetic retinopathy. Figure 1. and figure 2. Shows diabetic retinopathy and NPDR and PDR stages of diabetic retinopathy images respectively.

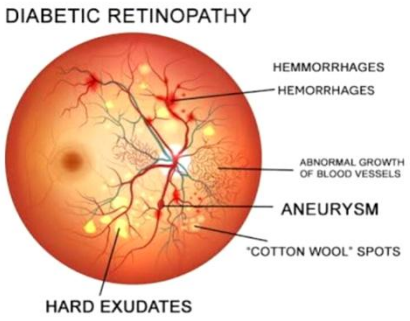


***Figure 1. Diabetic Retinopathy***

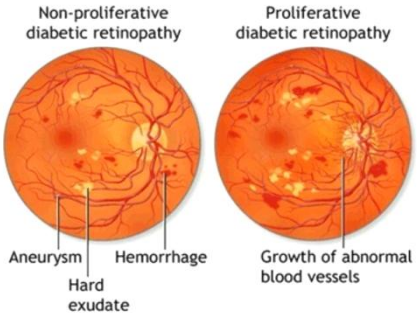


***Figure 2. NPDR and PDR stages***

Early stage of diabetic retinopathy is known as Non proliferative diabetic retinopathy (NPDR). This stage shows signs of micro-aneurysms, exudates and hemorrhages. Micro-aneurysms are small red spots occurring in the retina due capillary swellings. Exudates are white or yellow deposits caused leaking fluid from the capillary. Hemorrhages are red spots occurring due to rupturing of capillaries and micro aneurysms.

Later stage of diabetic retinopathy known as proliferative diabetic retinopathy (PDR) is characterized by excessive growth of new blood vessels in the retina. Leakage of blood vessels leads to loss of vision.

Age-related-macular degeneration - The AMD is a most common eye problem caused to a person whose age is 50 years and more. The macular is a sensitive part of the retina, located at the back of an eye, builds with more sensitive cells. Due to age, family history and smoking these cells begins to die or degenerate which leads to blurred vision or vision loss. Figure 3. Shows Age related macular degeneration image.

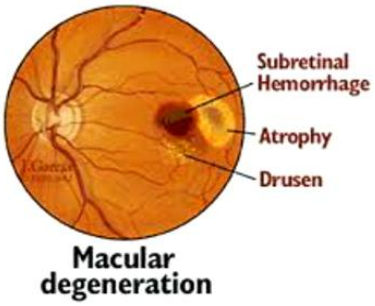


***Figure 3. Age related macular degeneration***

Due to increase in diabetes and ageing population in the society the rate of these diseases will be high in future. The patients are not aware of any symptoms until it is to late for the treatment. Only way to identify the diabetic retinopathy is by fundus image. Early detection of these diseases can protect against vision loss. Therefore the need for automated prediction of retinal diseases is raised. The motive is to predict and classify between diabetic retinopathy DR, AMD and normal fundus images by examining the texture of the retina background. The retinal disease prediction and classification is carried out with the help of image processing as a tool in MATLAB software.

## II.REVIEW OF LITERATURE

In [3], a method has been proposed to identify mild NPDR and severe NPDR using a procedure involving global image feature extraction. Using the scale and orientation selective Gabor filter banks, the abnormalities are detected.

In [4], the classification of the four stages of Diabetic Retinopathy using back propagation algorithm has been used by author.

In [5] presented a method which is automatic and involves two steps: optic disk detection and exudates detection. Firstly, the extraction of optic disk using propagation through radii method and then exudates detection using feature extraction, template matching and enhanced MDD classifiers is performed and the methods are compared.

In [6] suggested a new mechanism for Detection and Classification of Diabetic Retinopathy. The human retinal image is captured by using camera. Then the segmentation is performed on Retinal vascular. The density analysis and bounding box techniques are used to detect hemorrhage candidates. To classify the various stages of diabetic retinopathy which are normal, moderate and NPDR the Random Forests classifier is used.
In [7] suggested an Automatic Diabetic Retinopathy Detection approach using Fundus Images. The dark lesions in digital fundus photographs are detected to automate diabetic retinopathy detection system. Automatic detection system is introduced in order to find out the diabetic retinopathy consists of three steps which are preprocessing, feature extraction and classification. The preprocessing is used to eliminate the noise in Non-dilated RGB Retinal Fundus Images. The shape, size and intensity level features are extracted from image. And finally classifies the severity grade of the DR such as no DR, mild, moderate and severe DR.
In [8] introduced a new method for identify the diabetic retinopathy stages. The micro aneurysm detection in the input image is difficult task. In order to overcome this problem, the proposed algorithm is introduced which consists of three stages, they are preprocessing phase, Enhancement phase and Micro aneurysms detection phase. In preprocessing step, the median filter is used to remove the salt & pepper noise. After the Enhancement phase the Micro aneurysms are detected in retinal image. A set of optimally adjusted morphological operators are used for micro aneurysm detection in retinal images in this system.
In [9] surveyed for automatic detection of non-proliferative diabetic retinopathy. Authors reviewed, classified and compared the algorithms and techniques previously proposed in order to develop better and more effective algorithms that helps to diagnose DR in retinal fundus images.
In [10] investigated clinical sign of symptoms such as vessels, exudates, micro aneurysm and hemorrhages. The system identified four stages of diabetic retinopathy are normal, mild NPDR, moderate NPDR and severe NPDR and stages are classified using image processing and data-mining techniques. An association rule and C4.5 classifier are used to predict the unknown class.

## III. PROPOSED SYSTEM

### A. Block Diagram

In the proposed system, automatic prediction of type of retinal disease can be done using an image processing technique. The main goal of the proposed system is to predict the age-related macular degeneration (drusen) and diabetic retinopathy diseases in the retina and to automatically detect and segment the above diseases without human supervision or interaction. The block diagram of the system consists of mainly five stages, such as input image from database, pre-processing of input retina fundus image, image segmentation, feature extraction, classification of retinal diseases is as shown in Figure 4. As given below.

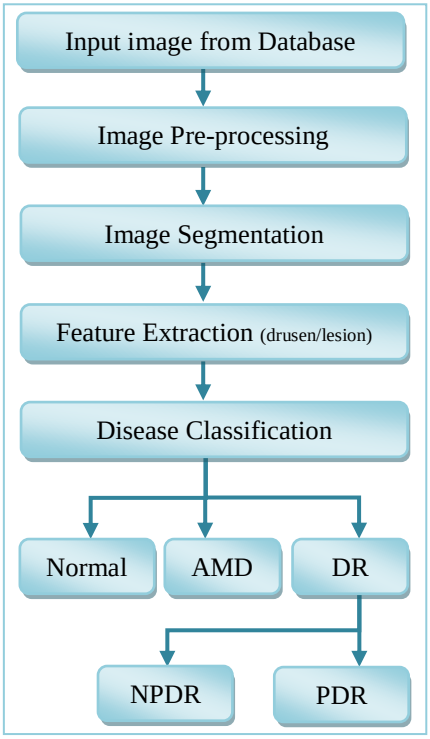


***Figure 4. Block diagram of proposed system***

**B. Modules**

In the proposed system, there are four modules of image processing for automatic prediction of retinal diseases, they are as follows:

1. Pre-Processing of a retinal fundus image.
2. Segmentation of image.
3. Feature Extraction.
4. Classification of retinal disease.

**1. Pre-Processing**

Pre-Processing of a retinal fundus image is the first step in the automatic prediction of retinal diseases. The quality of the acquired images is usually not good. So, it is necessary to improve the quality of retinal image. The purpose of pre-processing is to remove the noisy area from retinal image and enhance the image which is required for the reliable extraction of features and abnormalities as in the presence of noisy background feature extraction and abnormality detection algorithms give poor results.

**2. Segmentation**

Segmentation of an image refers to the process of partitioning a digital fundus image into multiple segments (sets of pixels, also known as super pixels). The aim of segmentation process is to simplify or change the representation of an image into more meaningful and easier to analyze form. Some segmentation techniques are masking, thresholding, edge detection, compression-based methods, histogram methods, region growing methods, and split and merge methods and boundary extraction.

**3. Feature Extraction**

In feature extraction process texture analysis is used to extract the features of the retina. The texture analysis includes texture recognition and texture based shape analysis. The texture can be extracted in two levels which are statistical and structural. On the statistical level, the texture of an image is defined by a set of statistics extracted from the entire texture region. On the structural level, a texture is defined by sub patterns which are called primitives. On capturing the variations in grey scale images the various statistical methods are based. The textural character of an image depends on the spatial size of texture primitives.

**4. Classification**

After feature extraction process, classification of retinal diseases is done. A classifier is used to classify the type of retinal disease and can automatically predict the type of disease. The location of drusen and diabetes's can be identified and by extracting the textural features of the retina, the type of disease and the extent/severity of disease spread can be determined. The proposed system predicts the disease classifies as normal, AMD and DR and also which stage (severity) of DR such as NPDR or PDR.

## IV. RESULT AND CONCLUSION

In diabetic retinopathy (DR), retina blood vessels are damaged due to fluid leakage from these vessels. Different lesions, i.e., Exudes, hemorrhages, micro aneurysms, and textures are used to detect the stage of DR. In AMD, retina is degenerated due to aging; drusens are used to detect AMD. DR and AMD is a disease which causes vision loss rapidly. The automatic detection system reduces the incidence of blindness. It is found that early diagnosis of these retinal diseases can reduce the chance of vision loss up to 50%. Image processing techniques discussed in this paper can detect the AMD and DR. The input color retinal images are of poor quality. Therefore, the images are pre-processed. After pre-processing, an image is segmented in required form for feature extraction. Features were extracted for classification process. As an achievement of this work, the AMD is predicted and DR when predicted has been classified into two stages NPDR and PDR.

In future work, the performance can be increased with more images data and better feature detection and more retinal diseases prediction within single system.

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