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Diagnosing Retinal Diseases Using Image Processing Techniques

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ABSTRACT : In worldwide, retinal diseases are found to be frequent cause of blindness for working age population in western countries. So, early diagnosis can prevent the blindness. We develop a system for the early diagnosis of diabetic retinopathy, glaucoma, retinoblastoma and age related macular degeneration using fundus images based on its symptoms. The images having different color variation inside the eye is compared by using images taken by high definition laser camera. These are called as fundus images. The feature extraction of these fundus images may be carried out using MATLAB software tool. Automatic screening will help to quickly identify the condition of the patients in a more accurate way. The macular abnormalities caused due to diabetic retinopathy can be detected by applying morphological operation, filters and thresholds on the fundus images of the patients[2]. On the fundus image of the patient glaucoma is caused by an increasing intraocular pressure with in the eye [1]. Diagnosis of glaucoma is done by applying K-means clustering algorithm and morphological operation. Retinoblastoma is caused due to the growing of cancerous tumor in the retina . Diagnosis of retinoblastoma is done by using fast Fourier transform and log transform. Age related is caused due to the degradation of the macular area. Diagnosis ARMD is done by applying histogram equalization and thresholding[4]. The diagnosing of four retinal diseases will be performed by the given user's retinal images and their corresponding symptoms through the graphical use interface. The processed output will be displayed to the user to identify the changes in our retina compared with the original image.

KEYWORDS: Diabetic Retinopathy, Glaucoma, Age Related Macular Degeneration, Retinoblastoma, fundus image, K-means clustering, Morphological operation, Histogram Equalization, Fast Fourier Transform.

I . INTRODUCTION

Eyesight is more precious than anything. Look at the world around and Think of how vulnerable the vision is. Now think how the world will be if we are losing our eyesight. The fundus of the eye is the interior surface of the eye, opposite the lens, and includes the retina, optic disc, Macula and fovea, and posterior pole. The fundus can be examined by ophthalmoscope and/or fundus photography .The screening of retinal based diseases can potentially reduce the risk of blindness. An early detection Enables laser therapy to be performed to prevent or delay visual loss and may be used to encourage improvement in eye care. In this paper, we diagnose four different type of common retinal diseases such as age related macular degeneration, diabetic retinopathy, glaucoma and retinoblastoma to detect and treat diseases in early stage.

Most of the people between the age group 20-74 years, DR is found to frequent cause of blindness. According to survey it is found that around 60 million people in India are diabetic among which youngster are more in number. DR will become a severe problem in worldwide. As per the data collected by world health organization around 366 million peoples are affected by diabetic within the year 2030. So early detection of diabetic retinopathy is most important in the world. In India, Macular degeneration is one of the most popular retinal diseases[4]. Mostly it is observed in people over the age of 65 and is therefore called age related Macular degeneration [6]. Glaucoma is a second leading cause of permanent blindness. It is known as "Silent Thief of Sight" [1]. It can only be diagnosed by regular eye examinations. Glaucoma most often occurs in adults over age 40, but it can also occur in young adults, children, and even infants. In African-Americans, glaucoma occurs more frequently at an earlier age and with greater loss of vision. So, early detection can avoid vision loss. Retinoblastoma affects newborn babies and children up to 5 years old. The average age at diagnosis is between 12-18 months while the majority of kids who develop

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retinoblastoma are born with it, most are not diagnosed at birth.

II. METHODOLOGY

The input image is obtained from digital fundus camera, then the preprocessing steps are followed. After that, the image is diagnosed by image processing techniques.Finally the type of disease will be displayed which is shown in fig 1.

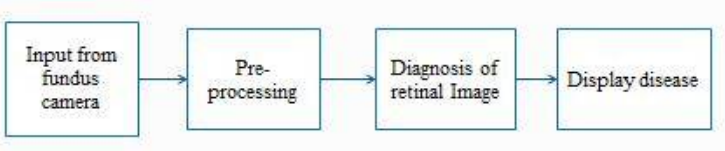

Figure:1 Block Diagram for diagnosing retinal diseases

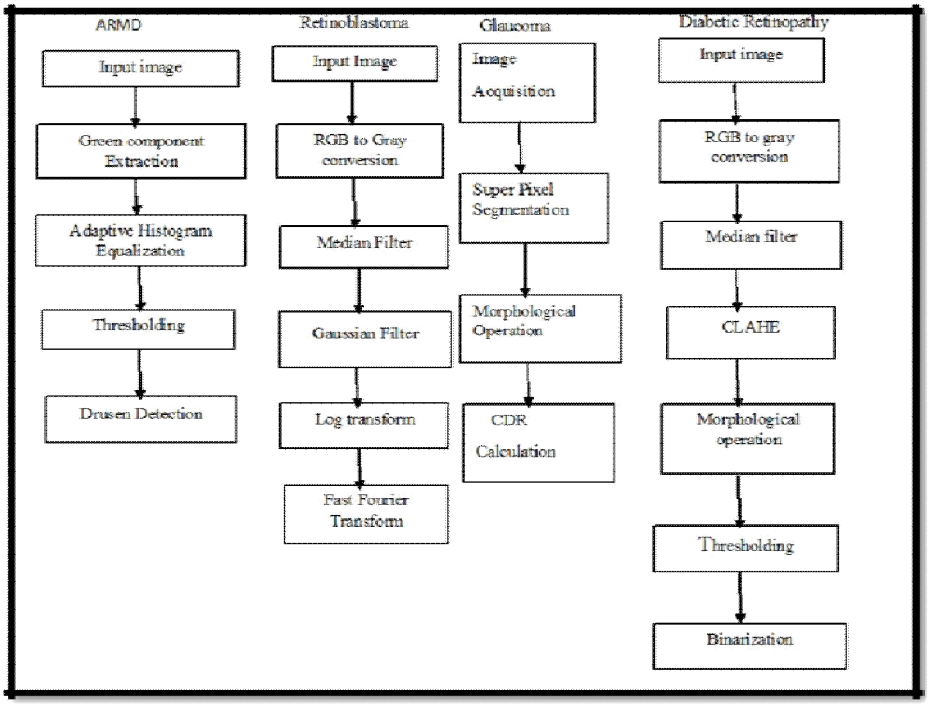

Figure:2. Detailed Block diagram for Diagnosing retinal Diseases

In Diabetic Retinopathy, First the retinal images are taken from patients using Digital fundus camera. The original image contains red, green, and blue component .RGB image is transformed into gray scale image for further processes. And then, filtering technique is used to reduce the effect of noise.Here we are using median filter. The median filter isa non-linear filter type and which is used to reduce the effect of noise without blurring the sharp edge. The result image of the median filter is enhanced by using Contrast limited Adaptive Histogram Equalization. Then we are applying morpholodical operation on the enhanced image. The morphological operations are dilation, erosion, closing and opening. Here we are using closing.Closing used to close the same intensity values.To convert the result of morphological into the binary image using the threshold value. Before we calculate the threshold value of the result of morphological using gray thresh method. Finally the exudates are detected in the retinal image.

In ARMD, the fundus images are classified into 3RGB channel i.e. Red, Green, and Blue. Among these three color components, the green component is used, as it has higher contrast between the drusen and the background[14].Adaptive Histogram equalization is a method in digital image processing that is used to enhance the

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contrast of the image. This method is disparate from ordinary histogram equalization. The Ordinary histogram equalization works on whole image while adaptive histogram operates on different parts of the image and uses them to reallocate the lightness value of the image. Due to this, even local lower contrast area gains a higher contrast. This is also called as contrast-limited adaptive histogram equalization. The drusen is detected by applying the threshold value, chosen from the intensity characteristics.

In Retinoblastoma, the original image (RGB) is converted into gray scale image. Then the median filter to remove the noise, it is a preprocessing step for improving results of later processing and it preserve the edges while removing noise[12]. After that, Gaussian filter is used to smooth the image. Next step is thresholding for providing black and white version of RGB image based on threshold value. Then the Fast Fourier Transform is used to decompose the real and imaginary components of a image in frequency domain. The frequency of that image is equal to the number of pixels in image. When we plot the 2D Fourier transform magnitude we need to scale the pixel values using log transform to expand the range of the dark pixels into the bright region. So we can better to see the transform.

In glaucoma, image acquisition is done by action of retrieving image from source. Super pixel segmentation is used to extract correct disc and cup boundaries. Number of super pixels is the only parameter for super pixel segmentation. Image segmentation is partitioning of image into multiple segments. K-Means clustering algorithm is applied here.

A .Diabetic Retinopathy

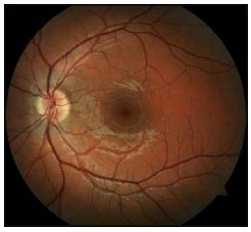

Figure3: Healthy Retina

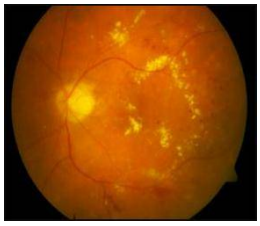

Figure4: Containing exudates

Retinopathy is a disease of the retina in Figure: 4. the retina is the nerve layer that lies the back of your eye. It is the part of your eye that "takes pictures" and sends the images to your brain. Retinopathy can affect all diabetics and becomes part icularly dangerous, increasing the risk of blindness it occurs when changes in blood Glucose levels cause changes in retinal blood vessels. In some cases, these Vessels will swell up and leak fluid into the rear of the eye[2].In other cases, abnormal blood vessels will grow on the surface of the retina.

B.Age Related Macular Degeneration

Age-related macular degeneration (AMD) in is a disease associated with aging that gradually destroys sharp, central vision[4]. Central vision is needed for seeing objects clearly and for common daily tasks such as reading and driving AMD

Figure: 5 Retinal image of AMD

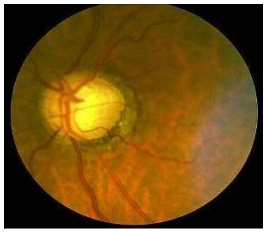

Figure: 6 Retinal image of Glaucoma

affects the macula, the part of the eye that allows you to see fine detail. AMD causes no pain. In some cases, AMD

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advances so slowly that people notice little change in their vision Fig: 5. In others, the disease progresses faster and may lead to a loss of vision in both eyes. AMD is a leading cause of vision loss in Americans 60 years of age and older.

C.Glaucoma

Glaucoma is a second leading cause of permanent blindness Fig:6. It is known as "Silent Thief of Sight"[1]. Glaucoma usually causes no symptoms and warnings. It can only be diagnosed by regular eye examinations. It is caused by an increase in intraocular pressure within eye. The optic nerve carries image information to brain. A liquid called: aqueous" is continuously flowing inside the eye. The liquid creates pressure on the internal surface of the eye. In normal eye this pressure is between 14 to 20mmHg.If it is between 20 to 24mmHg, it shows the symptoms of glaucoma.

D.Retinoblastoma

Retinoblastoma is a cancerous tumor that grows in the retina, a layer of nerve tissue in the back of the eye that senses light and sends images to the brain Fig:7 [6]. Many parents first see signs of retinoblastoma after noticing that their child's pupil (the dark circular area in the middle of the iris, the colored part of the eye) appears whitish in bright light. Some parents notice this effect in photographs. This happens because the pupil is translucent; so, retinal tumors that lie behind it may be noticeable. When diagnosed, most kids are treated successfully and able to preserve their sight while maintaining good vision.

Figure: 7 Retinal image of Retinoblastoma

IV. IMAGE PROCESSING TECHNIQUES

A. Age related macular degeneration

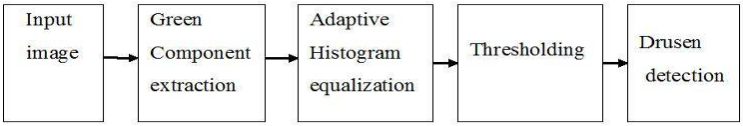

Figure:8 Block Diagram of AMD

A1.Green Component Extraction

The fundus images are classified into 3 RGB channels i.e. Red, Green and Blue. Among these three color components, the green component is used for pre-processing as it has higher contrast between the drusen and the background (Fig: 8) [4].

A2.Adaptive Histogram Equalization

Adaptive Histogram equalization is a method in digital image processing that is used to enhance the contrast of the image. Adaptive histogram operates on different parts of the image and uses them to reallocate the lightness value of the image. Due to this, even local lower contrast area gains a higher contrast. This is also called as contrast-limited adaptive histogram equalization[9] .

A3.Thresholding

Thresholding is a simple shape extraction technique, where the images could be viewed as the result of trying to separate the eye from the background [6]. Thresholding is a method of producing regions of uniformity within an image based on some threshold criterion [4].

A4. Drusen detection

In the images of retinal fundus, drusen appears as yellow spot across a red/orange background, so drusen information has uniqueness in intensity contrast which can be observed from the monochromatic image which helps to

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use the green band[7]. In green channel, after performing adaptive histogram equalization, the drusen spots are visible in higher visibility because of its high intensity. After that, threshold is applied to extract the high intensity drusen spot[4].

B. Diabetic Retinopathy

The exudates are detected by the following procedures

B1.Gray Scale Conversion

The acquired image resolution is 1280 × 1024 in 24bit JPEG format[11]. The color image of an eye is taken as input image and is converted to a grayscale image.

B2.Median filter

The median filter is a non-linear filter type and which is used to reduce the effect of noise without blurring the sharp edge (Fig: 9). The operation of the median filter is first arrange the pixel values in either the ascending or descending order and then compute the median value of the neighborhood pixels[8].

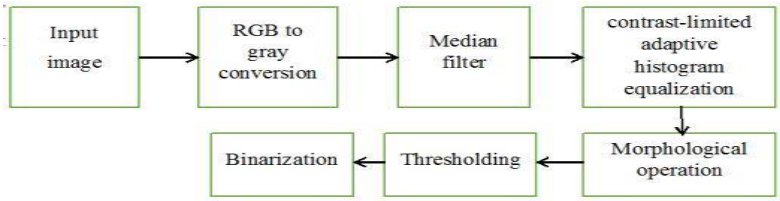

Figure: 9 Block Diagram of Diabetic Retinopathy

B3.Contrast-Limited Adaptive Histogram Equalization

It is explained in Age Related Macular Degeneration.

B4.Morphological Operations

Morphological operations can also be applied to grayscale images such that their light transfer functions are unknown[12]. It performs dilation and erosion .The structuring element is a small binary image, i.e. a small matrix of pixels, each with a value of zero or one.

B5.Binarization

This algorithm should automatically determine an intensity level to threshold an image to segment out the foreground from the background. The output of your function should be a binary image that is 0 for all background pixels and 1 for all foreground pixels[7].

C.Retinoblastoma

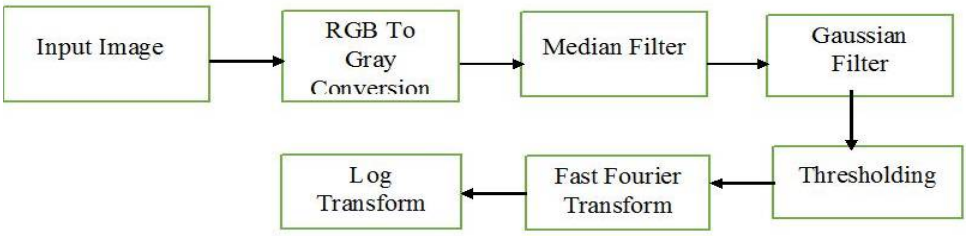

Figure: 10 Block Diagram of Retinoblastoma

C1.Gaussian Filter

The Gaussian filter is a non-uniform low pass filter. Gaussian filtering is more effective at smoothing image[7].

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C2.Fast Fourier Transform

Fourier Transform decomposes an image into its real and imaginary components which is a representation of the image in the frequency domain. If the input signal is an image then the number of frequencies in the frequency domain is equal to the number of pixels in the image or spatial domain. The inverse transform re-transforms the frequencies to the image in the spatial domain[9].

C3.Log Transform

The log transform of the image in Fourier space was performed using the equation s = log (r + 1). The log transform compressed the values of the light pixels of the image and expanded the values of the dark pixels of the image[10].

D.Glaucoma

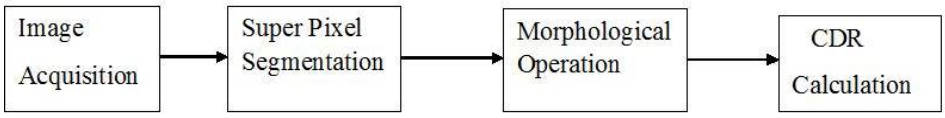

Figure: 11 Block Diagram of Glaucoma

D1.Image Acquisition

It can be broadly defined as action of retrieving an image from some source (Fig: 11).

D2.Super Pixel Segmentation

Segmentation is done on the region of interest to get disc boundary. Super pixel segmentation is used here[15]. This uses simple linear iterative clustering algorithm. The only parameter in this is K (the number of super pixels). As K value increases, accuracy increases but time required for evaluation also increases. If K value is very small then time required is less but results are poor. Clustering is a way to separate groups of objects. K-means clustering treats each object as having a location in space. It finds partition such that objects within each cluster are as close to each other as possible, and as far from objects in other clusters as possible.

D3.Morphological Operations

It is explained in Diabetic Retinopathy.

D4.Cup to Disc Ratio

Vertical cup diameter to vertical disc diameter ratio is calculated.

CDR=VCD/VDD

VCD-Vertical Cup Diameter ;VDD-Vertical Disc Diameter

When CDR I is greater than threshold then it is glaucomatous otherwise healthy[12].

IV.RESULTS AND DISCUSSION

The retinal images of affected or original image is diagnosed by using MATLAB software and implemented by using Graphical User Interface (GUI) because it is a pictorial interface to a program. Initially the original or affected image of the person is loaded[8].If it is original image, the line plot is clear and display ‘There is no disease’ else the line plot is unclear and display ‘your retina is affected’.Then the symptoms are selected by a patient, which is already predefined .After that, the corresponding disease of these symptoms is displayed by diagnosing of affected image .

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Fig.12. Diagnosis of ARMD

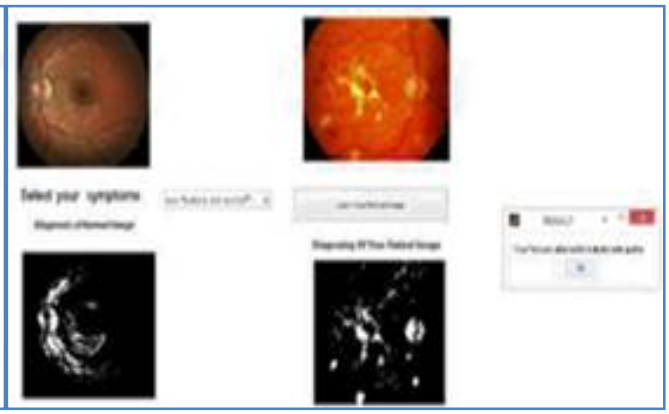

Fig.13. Diagnosis of diabetic retinopathy

Fig.14.Diagonosis of glaucoma

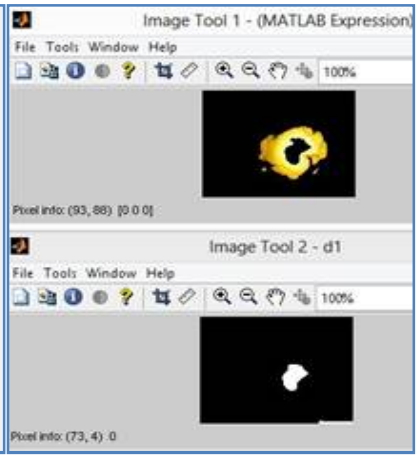

Fig.15.Optic Cup extraction

Fig.16.Calculation of VDD &VCD

The diagnosis of ARMD and diabetic retinopathy are shown in fig.12 & fig.13. Fig.14 portrays diagonosis of glaucoma, fig.15. portrays Optic Cup extraction and fig.16. portrays calculation of VDD &VCD. The diagnosis of retinal blastoma is shown in fig.17

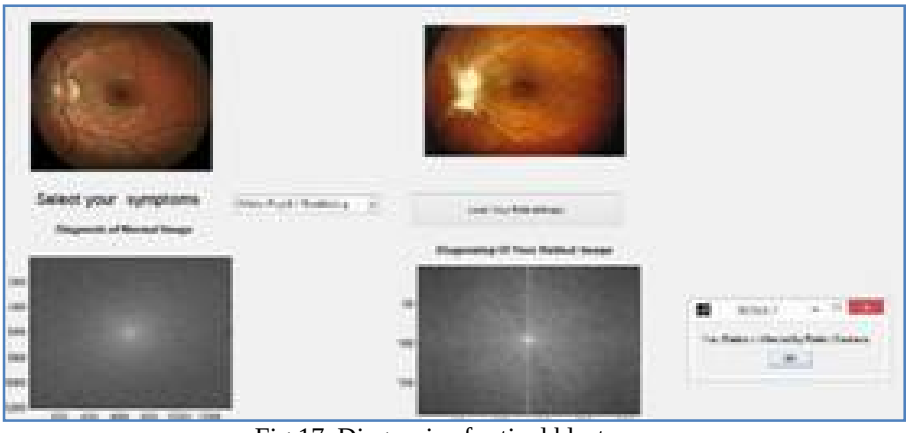

Fig.17. Diagnosis of retinal blastoma

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