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Survey of various transforms to discover optic disc from retina

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ABSTRACT

Early perception and confinement of optic disc are one of the crucial steps to detect the various diseases like Diabetic Retinopathy, Glaucoma and many other. Detection of optic disc in an exact way is very important in diabetic retinopathy wherein the retina the weak vessels start developing. Each of the vessels in the retina arises from the optic disc and each of them pursue the same directional pattern which is parabolic in nature. Normally Optic disc is circular in shape and it is set down 3 to 4mm to the higher part of the fovea. Diabetic Retinopathy is a disease which affects much of people having a high blood sugar level which will harm the blood vessels present in the retina. Early diagnosis of diabetic retinopathy is very important for which detection of Optic disc plays a very important role. With the help of various transforms like Discrete Wavelet Transform (DWT), Krisch Transform, Bottom Hat Transform can be done in a proper manner. By using DRIVE datasets which is publicly available the suggested method is being evaluated.

Keywords— *Optic disc, Diabetic retinopathy, Krisch transform, Discrete Wavelet Transform (DWT), Bottom hat transform, Drive dataset*

1. INTRODUCTION

For the total visionary, Eye is the principal organ present in the human body. People suffering from diabetes can have the chances or probability of suffering from the eye disease known as Diabetic Retinopathy. The effect of these disease on the retina can cause a great loss of vision. The retina is a thin, multi-layered, semi-transparent sheet of neural tissue that lines the inner aspect of the posterior two-thirds of the walls of the globe. For the examination of retinal images Optic disc and blood vessels plays a very crucial role. Manual examination of the affected eye takes a lot of time and cost so it is mainly prohibited to use them. From individual to individual the dimensions of the optic disc keeps changing but in 640x480 size color image, the number of pixels is around 40 to 60 pixels. By using a proper developed simple and properly resolved computerized method we can reduce the time and cost outstandingly. For the various application of images, investigation detection of Optic disc plays a fundamental role in initiating a framework of the source inside the retina picture. As stated by EDTRS (Early Treatment Retinopathy Study ResearchGroup) Categorization of Diabetic Retinopathy can be done in various ways. They can be classified as

A) Mild Non- Proliferative Retinopathy
This is the early stage in which micro-aneurysms takes place. Small areas of balloon-like swelling in the retina are the illustration of this disease. Roughly 40 percent of a person with diabetes are suffering from a Mild symptom of diabetic retinopathy.

B) Moderate Non- Proliferative Retinopathy
With the development of disease takes place, some of the blood vessels which nutrify the retina are choked up. Cotton wool spots and restricted quantity of bleeding can be spotted.

C) Severe Non-Proliferative Retinopathy
With preventing much of the region of the retina with the supply their blood much more of the blood Vessels are blocked.

D) Proliferative Retinopathy
This is the last and advanced stage in which the signals sent by the retina for the nourishment purpose increases the growth of the blood vessels.

An optic disc which is also known as optic nerve it is the point from where the ganglion cells axon moves out of the eye. As there is the absence of superimposing of cones and rodes with the optic disc, it represents a small blind spot which is present in each eye.

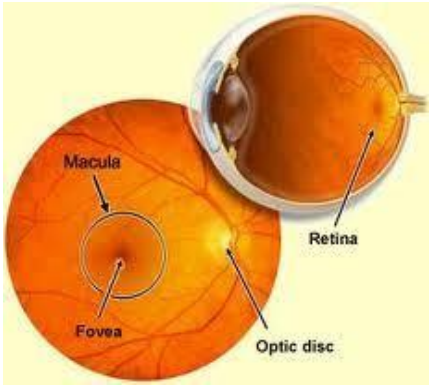

Fig. 1: Main features in color retinal fundus image

In the human eye, Macula is present nearby the center of the retina which is pigmented area oval in shape. In humans, macula has a diameter of 5.5mm which is divided into different parts like umbo, fovea, perifovea, parafovea. Being a, section of circulatory system and microcirculation system it delivers the blood everywhere in the body. The fovea is situated in the center of the macula. Figure 1 shows the color retinal fundus image with its different features.

This paper composed of different new algorithms for detection and separation of Optic disc from the retina. There are diverse steps include in the computations which are enlisted below: 1. Preprocessing is one of the basic step used for partitioning and inspection of retina image. This step also helpful for eliminating the clamour and inconsistent supply of intensity of the image. 2. Processing step will be easier and simpler way if the transformation of color RGB image to Gray image will occur. 3. A detachment of a bright object from the existing portion of the image is a mandatory act in image segmentation. 4. Next process is Windowing, it is a process of splitting the segmented image and after splitting the image what we get is known as Windows that carry various articles, 5. Various transforms like Discrete Wavelet Ttransform (DWT), Krisch Transform, Bottom Hat Transform is used in here for separation and detection of optic disc process. 6. After using transform now we are there to discover the Spectral density and Standard deviation for the various types of transforms. 7. The optic disc will be decided by checking out the windows having high Spectral Density and Standard Deviation. 8. There is Possibility Of two Windows having the same Standard Deviation and Spectral Density at that case we need to merge both the windows. If there are two windows with the highest Spectral density, Standard deviation, and Energy then there is a need for merging them both. 9. From the previous step, the separation and the detection process will take place.

2. LITERATURE SURVEY

Early diagnosis of Diabetic Retinopathy may reduce the possibility of blindness and vision loss.

Omar et al [1], suggested by using the basic filters the localization and detection of retina images can be done which will support the Ophthalmologists for recognition of any harmful eye diseases like glaucoma, Diabetic Retinopathy in the proper and appropriate way. There are 3 different phases which are included here. Firstly preprocessing phase which is used to amplify the retina images and to dismiss the noise. Secondly, Segmentation process in which segmentation of the retina's main part is done. Thirdly, the detection process takes place. In this process the recognition and categorizing the input image whether it is a left eye or right eye, which gets contaminated. In this system phase, the basic process in filters like average filters, spatial filters, median filters and morphological filters are being utilized here.

Anup Deshmukh, Tejas Patil [2], put forward a method on the basis of the feature extraction and local mean of pixels for making different categories of the bright object from retina images. In the proposed system the upgradation of the radiance of the image in the preprocessing is the necessitate pace for which the closing operation which is a morphological operation will be taken into place for determining the exact location and position of Optic disc in the retina. The enhancement of color fundus image is done with the help of the brightness transformation function. For the segmentation of optic disc morphological operator together with the Circular Hough transform is applied. From the retina images, to sort the pixels of exudate and non-exudate local mean and entropy region growing approach is used. In order to minimize the chances of false classification, an actual pre-processing of the various images for radiance modifications are required.

M.Foracchia, E.Grison [3], with the help of the geometrical representation of blood vessel composition the detection of optic disc from the retina fundus image can be executed. An innovative technique is used here to find out the location of the optic disc in the retina. The technique is established based on the introductory diagnosis of main retinal vessels. Each one of the blood vessel which emerge from the optic disc will follow the same path having directional pattern parabolic in nature. At any particular locality to explain the common route of retinal vessels a geometrical parametric representation was suggested, where the coordinate of the optic disc center are the two of the model parameter. The model variable recognized by a method of simulated annealing optimization techniques by using some experimental samples of vessel centerline points and correlating with the direction of the vessel which is given by some vessel identification procedure. Based on the availability of a good portion of the vascular structure this model does it work and doesn't depend on the genuine visibility of the optic disc or even its presence is not so important.

Amin Dehghani, Mohammad Shahram [4], for most of the disease diagnostic, vessel segmentation process and retina identification algorithm optic disc and its center localization is the foremost step. To draw out the histograms of every color constituent we are using the different retinal images in DRIVE dataset. For localizing the optic disc we have to calculate the average of the histogram for every color just as a template. In existence of pathological regions and also exudates in different images of the retina, we can correctly and precisely find the optic disc center by using some optic disc's histograms.

A.S.Jadhav, Pushpa B. Patil [5], concentrate on the innovative technique where from the fundus RGB image we are splitting up and detecting the optic disc with the help of the wavelet transform. After this process, the partitioning also known as windowing of the image is executed. In the windowing process, we get different windows for which we have to find out the optic disc we have to calculate the standard deviation and energy of each window. This suggested method is divided into four different levels. They are as follows: preprocessing of the input RGB image will first come into place. Then for the detection of the bright object segmentation of grayscale image will occur. Performing the windowing process to each of the segmented images and then the wavelet transforms being applied to each window in order to discover the standard deviation and energy. Selection of window size to find out the appropriate location of the optic disc in color fundus retina image is one of the originality of this paper.

Saiprasad Ravishankar, Arpit Jain [6], In order to detect diabetic retinopathy in early stage automated extraction of feature has done. To find the approximate location of the optic disc a new technique is used that is to first find the vital blood vessel and after finding the intersection of the respective blood vessel we can roughly find the position of the optic disc. Using various morphological operation we can find the different features such as blood vessels, hemorrhages, exudates, and microaneurysms. In cost function, the optic disc can easily be detected by merging the blood vessel convergence and high-intensity disk properties.

Ana Salazar, Djibril Kaba [7], As the morphology of the blood vessel and optic disc is an important aspect because they can indicate various diseases like glaucoma, hypertension. So this method can be used to bear the nonintrusive detection in this modern world of ophthalmology. Also for the segmentation of blood vessels and the optic disc in the retina different methods are suggested. For extracting the retina vascular tree the graph cut technique can be used. By calculating from retina the histogram of each and every color component and by averaging them we acquire template which is more effective and can be used for establishing the center of Optic disc and appropriate location in the retina. For preprocessing, the process includes distance transform, Contrast enhancement, and Adaptive histogram equalization. By merging different methods like compensation factor, MRF image reconstruction and mechanism of flux with the graph cut method a new innovative approach method is being introduced here.

Aliaa Abdel-Haleim [8], with the help of a vessels' direction, matched filter the detection of optic disc takes place. Illumination and Adaptive Histogram Equalization is used in order to normalize the luminescence and divergence from all over the image. The algorithm of optic disc detection depends on meeting the anticipated blood vessels directional pattern. Therefore a matched filter which is simple and uncomplicated is used here in order to roughly detect the direction of blood vessels in the optic disc region.

A simple procedure is presented here which is 2-D vessels direction matched filters used for discovering the Optic disc. Here are some more useful details are: Any improvement in the working of the vessel segmentation algorithm can affect the presentation and efficiency of the method. Improvement in performance can be seen by using the properties of different optic disc alongside the intensity and variances in order to minimize the center of the optic disc. Using diverse Vessel segmentation algorithms VDM (Vessel Direction Map) can acquire easily. To get a more complete and accurate outcome we are inspecting the performance of the already available detection methods of the optic disc like benchmark and datasets which are publicly available.

3. RECOMMENDED TECHNIQUES

The preliminary processing of the respective image includes a various process such as studying, contradiction, improving, filtering and resizing of the image. The different image has various sizes so for easy accessibility an image of the 256X256 pixel is used. The undesired noise will be discarded in the filtering operation. The optic disc is one of a feature of the retina which is an object piece. So, for detection of bright objects, the conversion of RGB image to Grayscale image is the necessary step we will be using here as shown in Figure 2.

After the detection of the optic disc, the next process is Segmentation in which the Grayscale image is sub-divided into various segments by utilizing suitable threshold value. Upcoming is the windowing process in which the binary image is split into various divisions known as Windows.

Various transforms are used here for the detection process like Discrete Wavelet transform, Hough Transform, and Bottom-hat Transform. After applying the different transform we will find Spectral density and Standard deviation for each window. The optic disc can be detected by verifying the windows having highest standard deviation and energy.

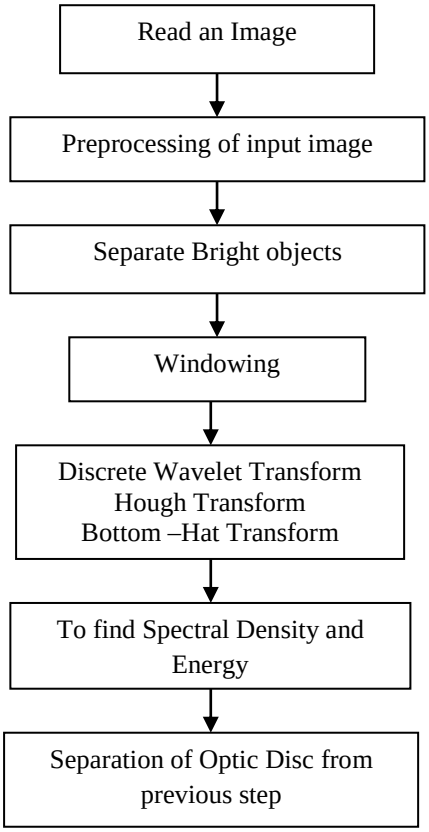

Fig. 2: Flowchart of recommended technique

4. DIFFERENT TYPES OF TRANSFORMS FOR OPTIC DISC DETECTION PURPOSE

For the computer-aided examination of retinal image detection of optic disc plays a crucial role and with the early detection of diabetic retinopathy, the possibility of various symptoms can be minimized like Vision loss, distorted vision or blindness. As the detection of optic disc can de operate with the help of various Transforms.

4.1 Wavelet Transform

In the field of image processing for the purpose of feature extraction, a Wavelet transform is being used. This transform is widely used because of its intrinsic ability for multi-resolution representation. Distributing the particular signal into tiny parts where every part is associated with various bands of frequencies is one of the jobs performed by the wavelet transform. The discrete Wavelet transform is used in order to overcome the time complexity. For image feature extraction discrete wavelet transform is used as it concurrently helps in the localization of signal in time and scale variables. Through Sub-band coding DWT can be implemented because of which they are mostly used for characterization, denoising, feature extraction, compression and face recognition.

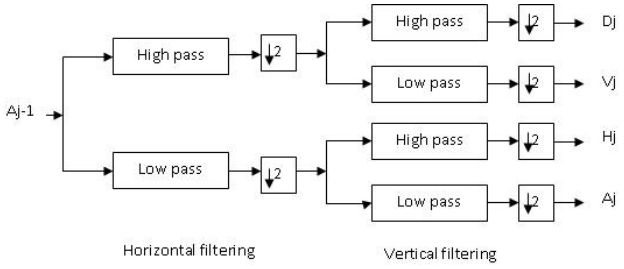

Fig. 3: Decomposition of Wavelet transform (Level one (1D))

There are various levels in which the decomposition of wavelet transform takes place. With the help of 2-D second level decomposition, the input image is disintegrated into

various sub-bands which localized into a particular and also here is the presence of scrutiny filters bank which is accompanied by decination filters. At each decomposition level, scrutiny filters bank holds a set of high as well as low pass filters. As the input image goes through this filters it breaks into two bands. Low pass filter helps in order to get rough details about the various input image features. By using two different 1D transform operation 2D that is 2nd level decomposition will take place. In the one level decomposition of the wavelet transform, the filtering which will take place will be horizontal and vertical filtering. The input image passes through this high and low filters which are then down sampled by 2. After downsampling, the process will split the respective image into 4 different bands i.e LL (A_j), LH (H_j), HL (V_j), HH (D_j).

Fig. 4: A sample of 2D Discrete Wavelet Transform

Figure 4 shows how a sample of two-level decomposition of discrete wavelet transform looks like. For the decomposition of DWT from 1, 2,…..up to k the availability of subbands can find out by using (3X k) +1.

For easy processing, the fundus retina image which holds more color is converted into a grayscale image which has less content of data. Using a suitable threshold value the image is segmented because of which it becomes a binary image which holds only bright objects. After the windowing process takes place the image is segmented into different windows. The windows having higher Standard deviation and Energy contains the Optic disc. Fig.5 and Fig.6 show the original image we used and its optic disc detection. The thresholding can be represented as:

Pixel value = 1; $if\ f(i,j) > Tr$

= 0; $otherwise$

Where Tr - threshold value of intensity.

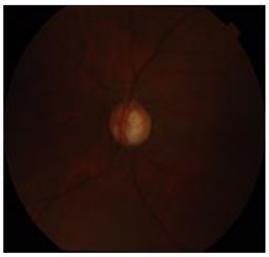

Fig. 5: Original Image

Fig. 6: Optic Disc detected image

4.2 Bottom Hat Transform

From the given image in order to extract the small elements and details an operation known as Top hat Transform is used in mathematical morphology and digital image processing. Basically, there are 2 different types of Top-hat Transform i.e. White top-hat Transform and Black top-hat Transform. The difference between the Input image and its opening by some structuring element is known as White top-hat Transform And the difference between the closing and the input image known as Black top-hat Transform.

Let f: E ⟶ R be a grayscale image, mapping points from a Euclidean space or discrete grid E (such as R^2 or Z^2) into the real line. Let *b(x)* be a grayscale structuring element.

White top-hat transform can be shown as

$$T_w(f) = f - f \circ b$$

Where, ○ denotes the opening operation.

Black top-Hat transform can be shown as:

$$T_b(f) = f \bullet b - f$$

Where, ● is the closing operation?

Removal of options disc from the retinal fundus image is what we focus on the preprocessing phase. Some general features of optic disc are constant size, high intensity, and circular shape. There is a possibility for the appearance of some dark objects in the inner part of the optic disc which is known as Hemorrhages (HAs).

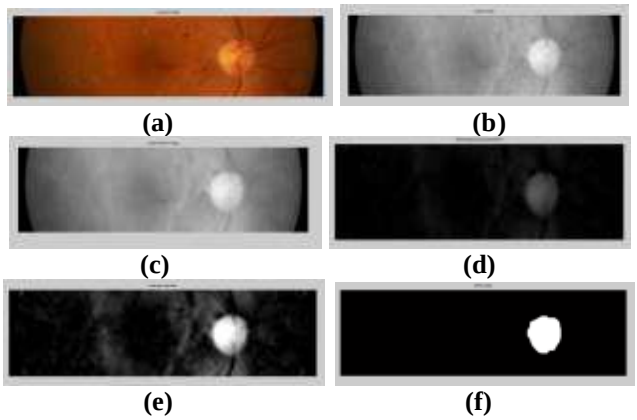

Fig. 7: Optic disc removal steps demonstration (a)Input image, (b)Red channel extracted image, (c)Median filtered image, (d)Morphological Top-Hat Transform image, (e)Contrast enhanced image, (f)Rough Location of optic disc

Removal of the optic disc will help in eliminating the confusion of the objects which may be invalidly detected as hemorrhages. Due to the location of fundus image optic disc will consistently remain in the middle area of fundus image with the help of this we can get accurate results and also there is a reduction in the computational time. Now, we will mainly focus on the third middle region of the particular image. In order to improve the contrast process called contrast stretching is used. By defining the respective upper and lower pixels limits of the image the process can be executed in the more proper way. Figure 7 shows the results of contrast stretching.

With the help of morphological operations like opening and closing operation, the rough position of optic disc can be detected. For discarding tiny objects morphological operation is executed. After detecting the exact location of the optic disc in the cropped image it is important to resize the trimmed image into its authentic image. In order to resize the image a process known as padding zero processes is used. After resizing the resulted image, then that image will be enhanced in order to achieve mask of the optic disc region. After the mask is detected it is then cross-checked with the respective input image.

4.3 Hough Transform

Hough Transform is used to detect the circle of the optic disc. Hough transform helps to find out the center and the radius of the optic disc which will then approximate the boundary of the optic disc. As in the fundus image, the optic disc is the brightest area, the detection of the potential circles can be done by Hough transform. The transform is applied to the gradient image in order to detect the center and the boundary

of the Optic disc. For detecting the shape in a particular image Hough transform is used. Hough Transform works by transforming the image into a parametric space which is established basically to narrate the required shape analytically. The circular Hough Transform is much more similar to Hough transform for lines, so for circle, a parametric form is used that is equation 1.

Where (a,b) denotes the center of the circle where r is the Radius that passes through axis (x,y).

In a circular region, Hough transform is used to detect the contour of the optic disc. Since the computational complexity of the Hough transforms mainly depends on the number of radii and number of Edge pixels to be matched hence this parameter are reduced by Hough transform in order to minimize the complexity. Fig.8 shows the detection of optic disc of various images taken from the DRIVE database.

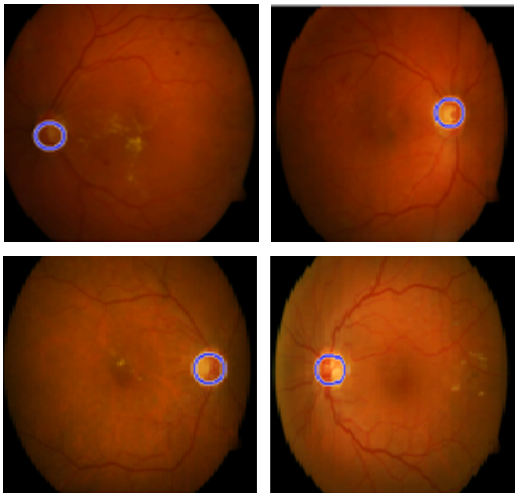

Fig. 8: Detection of optic disc

5. CONCLUSION

With help of various transforms here we are detecting the optic disc from the various image which we use from the DRIVE dataset. One necessary point is that the Segmentation process is not proper in Bottom-Hat Transform while it is proper in the Discrete Wavelet Transform and Krisch transform. The method will be executed in various steps like Pre-processing of an image taken as input, Separation of Bright objects, Windowing process in which the image is being segmented into various windows. After all the process different transform is to be applied and later to find the Spectral density and Energy of the respective window. The Optic disc will be present in the window holding the highest Spectral density and Energy.

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