Develop a Novel Screening Tool Based on Wavelet Transform for Identification of Diabetic Retinopathy

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ABSTRACT
Diabetes is a long term organ disorder that occurs when the level of blood sugar is huge as pancreas does not produce enough insulin in body or alternatively, cells do not react well to insulin. Diabetic Retinopathy (DR) is the critical and most common eye related disease which arises on diabetic patients. It appear when the blood vessels of retina started to swell and leaks blood that at last became major source of vision loss. Early retinal screening is the best solution to prevent from Diabetic Retinopathy. In this paper we present an Image Retrieval method which find and retrieve the patient's retina image from the Database of normal and DR affected images. A retrieval process will be developed by extracting image's features by using Discrete Wavelet Transform (DWT) and checking the similarity between the query and database image by measuring the Euclidean distance. The Discrete Wavelet Transform retrieval system will give fast search over the number of images and improve accuracy. The presented system will reduces the professionals work to analyze every fundus image rather than diabetic affected image and develop a prototypical DR image management system to improve diagnostic performance.

Keyword **-** Image Retrieval, Discrete wavelet transform, Diabetic Retinopathy, Euclidean distance, Retina image.

I INTRODUCTION

As the time goes the number of diabetic patients has been increased. It arises when the blood sugar level is very high either due to inadequate production of insulin in body or the cells do not respond properly to insulin [1]. Due to diabetic diseases body blood vessels may get weakened and it can affect different regions of physical structure. When glucose level in retinal blood vessels is high, the sight will be affected and obscured and cause blindness. This is known as Diabetic Retinopathy [2]. It damages the small blood vessels present in retina which may result in bleed or leak fluid and distorting vision. The risk of the DR becomes more affected and danger with age and so older diabetic patients are prone to Diabetic Retinopathy [3-5].

There are four different stages of diabetic retinopathy. The condition of DR may increases from no or mild retinopathy to a much more severe stage. The explanation of Different stages is given as [6-9]:

(a) **Mild nonproliferative diabetic retinopathy:** it is the first stage of DR. In this stage the retina's small blood vessels are started to swell which is called microaneurysms.
(b) **Moderate nonproliferative diabetic retinopathy:** in this stage the swelling increases and the blood vessels started to distort.
(c) **Severe nonproliferative diabetic retinopathy:** in this stage the many blood vessels are blocked due to which blood supply to retina areas are deprived.
(d) **Proliferative diabetic retinopathy:** it is the last and most dangers stage in which new fragile blood vessels of retina can begin to grow. This new vessels can leak blood and pull on the retina as they grow which causes of vision loss.

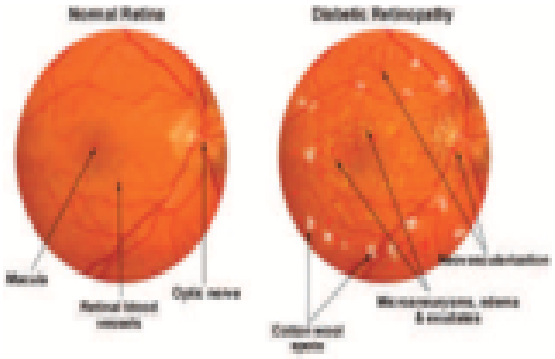

Fig. 1: **Retinal image**

The early detection of diabetic retinopathy stages can effectively reduce the risk of vision loss in diabetic patients. For the detection process the content based image retrieval technique become more popular [10-12]. CBIR is an automatic image retrieval system based on some specific characteristic like color, shape and Texture. The main purpose of the presented work is to retrieve images matched with the patient's retina image from retina's databases by using DWT based feature extraction technique. Feature extraction is the essential act in the design of retrieval model in which we extract unique and important information from the image [13]. Here the DWT is used to create the feature vector properties. The input retina image is compared with the image database by extracting features from images and computing Euclidean distance between them which is used for the purpose of similarity comparison. At last the images with minimum distance are displayed.

II PROPOSED SYSTEM

This system proposes an algorithm for automatic detection of DR using digital retina images. On the regard of difficulties that arise due to the direct application of typical expansion techniques to Diabetic Retinopathy, we propose to utilize DWT technique.

(a) Discrete Wavelet Transform: By far the most useful information that can be extracted from images for matching purpose is the image's feature point like-energy. Energy is the most popular feature of an image and it is very easy to find and operate. This paper try to analyze such a technique that matches images based on their energy feature describe by DWT [14].

DWT decompose an image not only in one but in number of basis function and because of their multi-resolution behavior it gives fast search over the number of images [15-17]. DWT is that decode constantly from low to high resolution. It divides the image into low and high frequency element. The low frequency is again divided into high and low frequency elements. Many researchers are interested by it because it does not damage by rotation, scaling and translation of an image. Here we find quadratic distance between two color retinal images are from database and query image. First decompose the image in 4 sub-bands using DWT then energy of lower sub-band are calculated. Finally evaluate the Euclidean distance from database to query image [18].

(b) Algorithm & Flow Chart:

(i) Input the query image.

(ii) Resize image to 256×256.

(iii) Convert the RGB query image into Grey image [19].

(iv) Decompose the image into four sub-images by applying Discrete Wavelet transform (DWT).

(v) Find out the value of energy of lower subband [20], using following formula:

$$E = \frac{1}{N}\sum_{xy}(I_{m,n})^2 \qquad (1)$$

Where I is the intensity of the pixel located at row m and column n and N is the total number pixel.

(vi) Create the retinal image database which contains images of various diabetic retinopathy signs.

(vii) Reading all the retinal images from database.

(viii) Resize to 256×256.

(ix) Decompose each and every image of Database separately by using DWT and Calculate Energy of lower sub-bands for each image.

(x) Storing the feature vectors as an array.

(xi) Comparing the feature vector of query image with data base images using Euclidean distance [21]. Euclidean distance (ED) measures the distance between two vectors of Images as:

$$ED = \sqrt{\sum_{x=1}^{k}(E_x - D_x)^2} \qquad (2)$$

Where E_X is the query feature vector and D_x is the dataset feature vector. k is the total number of feature vectors.

(xii) Arranging them in a sorted order.

(xiii) Find the minimum distance and give similar images as result.

(xiv) To measure performance of the system calculate precision and recall by following formulae:

$$\text{Precision} = \frac{(\text{No. of retrieved images that are relevant.})}{\text{Total no. of retrieved images}} \qquad (3)$$

$$\text{Recall} = \frac{(\text{No. of retrieved images that are relevant})}{\text{Number of relevant images in the database}} \qquad (4)$$

Fig.2 depicts the overall methodology in detection of diabetic retinopathy.

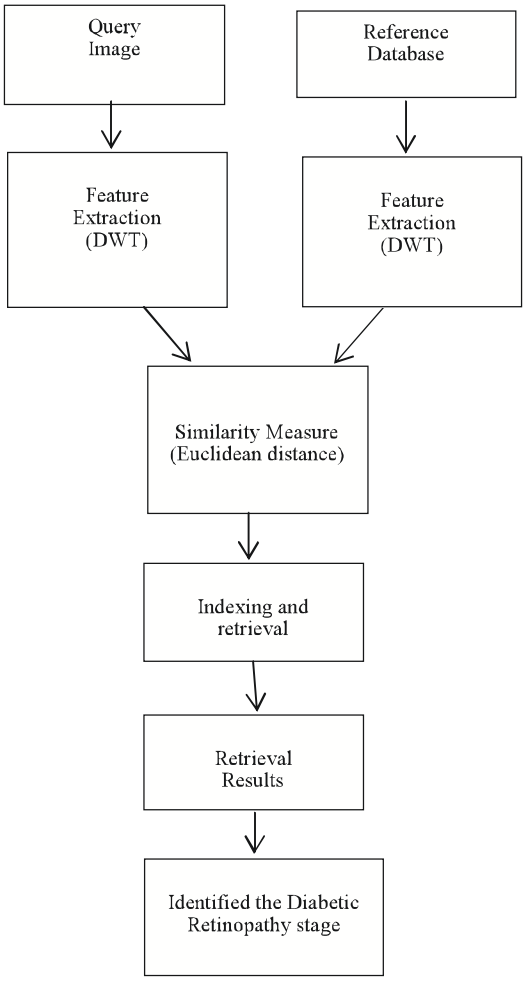

Fig. 2: **Flowchart of the proposed methodology**

III EXPERIMENTAL RESULTS

The retinal image database which contains images of various diabetic retinopathy signs are collected and analyzed from Aashirwad Laser & Phaco Eye Hospital Bilaspur. The patient's retina images (Shown in fig.3) are processed and features are extracted using DWT as shown in fig 4.

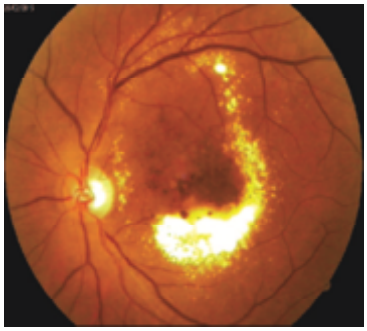

Fig.3: Query image

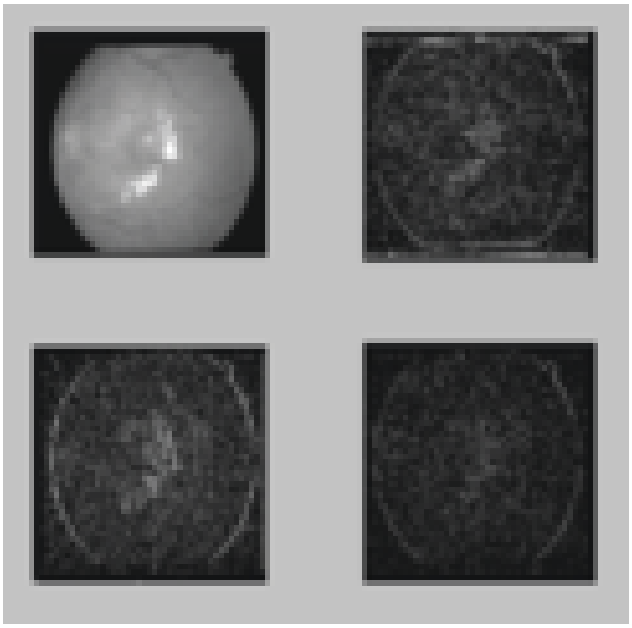

Fig.4: Wavelet Transform of Query image

After finding energy of each and every database images, the results are measured by Euclidean distance. According to minimum Euclidean distances the result is sorted in descending order and the top 5 most similar image is shown in fig 4 which is all related to nonprolifrative diabetic retinopathy. The table I shows the Euclidean distances between query image and the database image.

The precision and recall is calculated as:

- Precision: 64%
- Recall: 57%

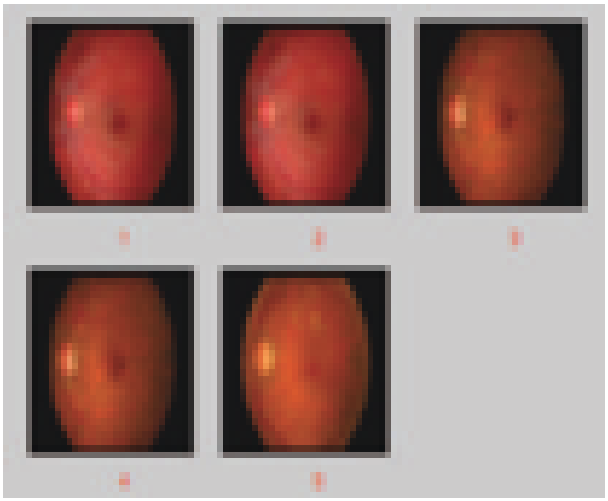

Fig. 5: The Retrieve retina image

Table 1
Euclidean Distance of Retinal Images

S. No.	Euclidean distance
1	0.149
2	0.151
3	0.156
4	0.162
5	0.171

Displayed result: "Patient has nonproliferative Diabetic retinopathy".

IV CONCLUSION

Early detection and timely treatment of DR can reduce the growth of it and prevent blindness. The Retrieval algorithm presented in this paper reduces the complex computational work and at the same time improves the detection process. The accuracy is also improved because the images are matched on the base of energy feature extracted by DWT. The experiment result shows that the limited numbers of relevant image is retrieved with precision rate of 64% and recall rate of 57% to reduce the analysis time. As this method is implemented in Matlab software, it can be applicable freely in numbers of real time applications.

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