Color Histogram Based Image Retrieval Technique for Diabetic Retinopathy Detection

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***Abstract* - Diabetic Retinopathy (DR) is the critical and most common eye related disease. Early detection of DR is the best solution to prevent from this disease. This paper proposes an Image Retrieval technique that search and retrieve the query image from retinal Database. A retrieval process will be developed by extracting color histogram feature and then find the feature vector of desired size by setting the number of bins in histogram. For checking similarity Euclidean distance will be calculated between the query and database image. The color histogram retrieval system in HSV color space will provide better performance than in RGB color space. 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.**

Index Terms - Image Retrieval, Histogram, Diabetic Retinopathy.

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.

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 color histogram 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 Color histogram 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 color histogram technique.

A. Color Histogram: By far the most useful information that can be extracted from images for matching purpose is the image's color. Color is the most popular and visual 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 color feature describe by histogram [14].

Color Histogram is generally depends on the intensity of RGB channels and gives separate histograms for each channel. It shows the pixels that have colors in fixed list form which is used for fast search over the number of images [15-17]. The components present in a histogram depend on the number of bits in each pixel in an image. 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 calculate the histogram count values for images and find difference matrix. Now find Similarity matrix between two images using sin function. Finally

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evaluate the distance from database to query image [18].

B. Algorithm & Flow Chart:

1) Input the query query image
2) Resize image to 256×256.
3) Convert the RGB query image into histogram image.
4) Calculate feature vectors- mean, Standard deviation and skewness [19].
5) Create the retinal image database which contains images of various diabetic retinopathy signs
6) Reading all the retinal images from database.
7) Resize to 256×256 and calculate the histograms for each image in the Data base separately.
8) Calculate feature point- mean, Standard deviation and skewness for each image in database as:

Mean:

$$E_k = \sum_{N}^{l=1} \frac{1}{N} P_{kl} \tag{1}$$

Standard deviation:

$$\sigma_k = \sqrt{\left(\frac{1}{N}\sum_{N}^{l=1}(P_{kl} - E_k)^2\right)} \tag{2}$$

Skewness

$$S_k = \sqrt{\left(\frac{1}{N}\sum_{N}^{l=1}(P_{kl} - E_k)^3\right)} \tag{3}$$

9) Storing the feature vectors as an array.
10) Comparing the feature vector of query image with data base images using Euclidean distance [20]. Euclidean distance (D) measures the distance between two vectors of Images as:

$$D = \sum_{k=1}^{m} w_{k1}|E_k^1 - E_k^2| + w_{k2}|\sigma_k^1 - \sigma_k^2| + w_{k3}|S_k^1 - S_k^2| \tag{4}$$

Where: P_{kl} = the k_{th} channel at the l_{th} color pixel
k: is the present channel point (e.g. 1 = H, 2 = S, 3 = V)
m: is the channel's number
E_k^1, E_k^2: is the mean of the query and database image.
σ_k^1, σ_k^2: is the standard deviation (Std) of query and database image.
S_k^1, S_k^2: is the skewness of query and database image.
W_k: is the load for each point.
11) Arranging them in a sorted order
12) Find the minimum distance and give similar images as result.
13) To measure performance of the system calculate precision and recall by following formulae:

$$\text{Precision} = \frac{(\text{No. of retrieved images that are relevant})}{\text{Total no. of retrieved images}} \tag{5}$$

$$\text{Recall} = \frac{(\text{No. of retrieved images that are relevant})}{\text{Number of relevant images in the database}} \tag{6}$$

Fig.1 depicts the overall methodology in detection of diabetic retinopathy.

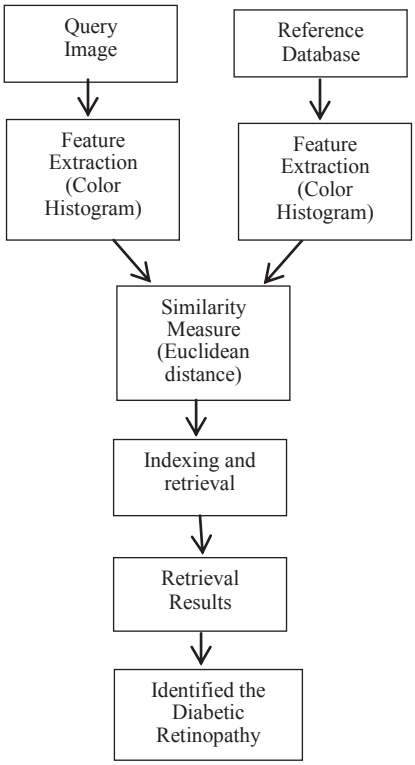

Fig.1: Flowchart of the proposed methodology

III. Experimental Results

The retinal image database which contains images of various diabetic retinopathy signs are collected and analyzed [21]. The patient's retina images are processed and features are extracted using color histogram as shown in fig 2.

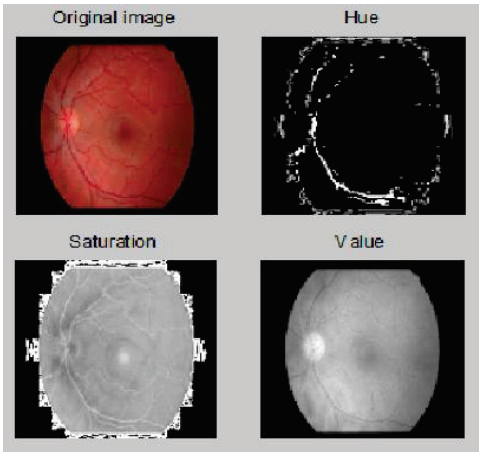

Fig.2: The Different planes of HSV color space

After finding entire features: Hue, saturation, value, mean, standard deviation and skewness of each and every database images, the results is measured by Euclidean distance. According to minimum Euclidean distances the result is sorted in descending order and the most similar image is shown in fig 3.

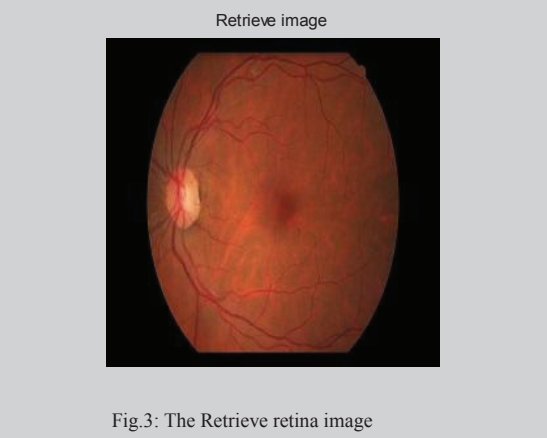

Fig.3: The Retrieve retina image

Precision: 61%

Recall: 58%

The table I shows the feature extracted vector of retinal images. Each type of retinal image (normal and abnormal) has different extracted value. The table II shows the Euclidean distances between query image and the database image.

TABLE I
Feature Extraction Vector of retinal images

Img	Feature Extraction								
	Hue plane			Saturation Plane			Value Plane		
	Mean (E_1)	Std (σ_1)	Skew-Ness (S_1)	Mean (E_2)	Std (σ_2)	Skew-Ness (S_2)	Mean (E_3)	Std (σ_3)	Skew-Ness (S_3)
1	0.04	0.056	8.57	0.57	0.41	-0.57	0.38	0.32	-0.05
2	0.05	0.054	8.62	0.55	0.47	-0.58	0.37	0.38	-0.07
3	0.03	0.057	8.82	0.45	0.45	-0.59	0.34	0.36	-0.04
4	0.04	0.058	8.92	0.59	0.51	-0.50	0.40	0.32	-0.07
5	0.05	0.18	4.14	0.47	0.33	-0.48	0.37	0.39	-0.19
6	0.06	0.20	4.24	0.49	0.43	-0.58	0.39	0.31	-0.18
7	0.03	0.17	4.44	0.48	0.35	-0.47	0.38	0.37	-0.20
8	0.07	0.20	-0.63	0.65	0.44	-0.80	0.51	0.35	-0.60
9	0.09	0.22	-0.67	0.69	0.48	-0.82	0.56	0.39	-0.62
10	0.11	0.18	4.64	0.49	0.38	-0.49	0.39	0.38	-0.22
11	0.13	0.26	-0.62	0.56	0.47	-0.83	0.54	0.38	-0.69
12	0.15	0.25	-0.60	0.68	0.50	-0.87	0.58	0.30	-0.72

TABLE II
Euclidean distance of retinal images

Retina Image	Euclidean distance			
	Hue plane	Saturation Plane	Value Plane	Overall image
1	0.022	0.087	0.054	0.104
2	0.025	0.086	0.058	0.107
3	0.021	0.089	0.060	0.109
4	0.027	0.088	0.061	0.111
5	0.026	0.091	0.068	0.116
6	0.028	0.097	0.071	0.123
7	0.030	0.099	0.074	0.127
8	0.038	0.101	0.079	0.133
9	0.035	0.106	0.080	0.137
10	0.038	0.108	0.084	0.142
11	0.041	0.112	0.086	0.147
12	0.044	0.114	0.087	0.150

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 both pixel and color information. The experiment result shows that the limited numbers of relevant image is retrieved with precision rate of 61% and recall rate of 58% 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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