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ENHANCED DETECTION OF DIABETIC RETINOPATHY

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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.

Keywords: HSV, DR, RGB, color histogram, database.

I INTRODUCTION

In recent years, with the rapid development of digital image processing technology, helping the user to find the multimedia information what they need quickly and effectively becomes a hot research topic at present. Due to diabetic diseases body blood vessels

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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. Image retrieval is a major component of multimedia information retrieval technology, and also one of the basic theory of video information retrieval, it play a significant role in the field of information retrieval. Image retrieval is based on users' query requests, extract an image or image set that related to the query image from the image dataset. The Minority-based image retrieval has been proposed in the early 1990's. This approach is to retrieve images using low-level features like color, texture and shape that can represent an image. Color is a very important visual cue for image retrieval and object recognition. Color histograms are invariant to orientation and scale, and this feature makes it more powerful in image classification. Color histogram-based image retrieval is easy to implement and widely used in image retrieval systems. Some of the commonly used color descriptors including compact color moments, the color coherence vector, and color correlo-gram. Texture is one of the most important characteristics of an image. Texture features are also widely used in image retrieval systems. Various algorithms have been designed for texture analysis, such as gray level co-occurrence matrices, the Tamura texture feature, the Markov random field model, Gabor filtering, and local binary patterns based on human visual psychology research put forward some different methods to describe the texture feature, give a description of several different terms: coarseness contrast and directionality, line likeness, regularity, roughness, etc. In addition to color and texture features, shape feature is the most essential characteristics of depicting objects. But it is also most difficult to describe.

Although national retrievalclothing image have complex visual features, the main characteristics still are clothing color, fabric texture and totem shape, which are in accordance with the image feature in computer vision. So we can use traditional feature extraction algorithms to extract the features of retrieval images. At present, a large number of approaches on extraction of color, texture and shape features have been put forward and have already obtained good results in many fields. Color is the most dominant and distinguishing visual feature. The existing color feature extraction methods include color histogram, color moment, color coherence vector and color correlogram. In the current version of the MPEG-7 Final Committee Draft, several color descriptors have been approved including number of histogram descriptors. Texture is used to specify the roughness or coarseness of object surface and described as a pattern with some kind of regularity. Many researchers have put forward various algorithms for texture analysis, such as the famous gray level co-occurrence matrix (GLCM), local binary patterns (LBP), local directional patterns (LDP), and so on. With the continuously expanding of the application field, new theory, like the theory of wavelet, is introduced. And used Gabor filters to extract texture features. Shape is the most essential feature of the object. The classic shape descriptors are the the Fourier transform coefficients and the histogram of oriented gradients (HOG). The retrieval image have very complex visual features, which make it more difficult to be expressed by single feature extraction algorithm. So our goal is to design a feature extraction algorithm based on multi-features to express the information of retrieval image comprehensively. A lot of image feature extraction algorithms based on

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multi-features have been proposed in recent years. In 2010,presents a novel image feature representation method, called multi-texton histogram, for image retrieval. It integrates the advantages of co-occurrence matrix and histogram by representing the attribute of co-occurrence matrix using histogram. Micro-structure descriptor proposed by built based on the underlying colors in micro-structures with similar edge orientation. It effectively integrates color, texture, shape and color layout information as a whole for image retrieval also proposed color difference histogram in 2013. The major difficulty is the segmentation of interested target. Currently commonly used to describe the shape of image retrieval methods mainly include two categories: based on edge and based on the shape of the area. The former using the edge information of images, while the latter using the area of gray level distribution information. Classical methods of describing shape features include the use of moment invariants, Fourier transforms coefficients, edge curvature and arc length. This paper uses the color and edge orientation feature that describe the texture information correctly. The rest of this paper is organized as follows: we describe the HSV color space and the color and edge orientation quantization scheme in the HSV color space. we describe the feature extract and feature fusion. In the experiments and results were introduced. Finally is the conclusion of this paper.

II LITERATURE REVIEW

In general the first step in computer based retinal image diagnosis is image pre-processing. Image pre-processing includes different techniques such as image enhancement, brightness or contrast enhancement, segmentation, decolorizing, resizing, image de-noising, etc.

In 2006, Alia, et al. presented a comparative study of contrast enhancement techniques for retinal images analysis. The work explored the advantages and disadvantages of

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the various contrast enhancement techniques.

In 2008, Andrea, et al. proposed a method to minimize the non-uniform lighting effect. The technique explored is an adaptive histogram equalization technique. For generalization purpose, this technique is not more effective.

In 2008, George, et al. applied derivative based method for background foreground differentiation. They used convolution of 2D Gaussian kernels with the second derivatives of the input image. The key feature of retinal images used here is blood vessel. The drawback of the system is minimum accuracy.

In 2008, Jian, et al. suggested directional field based retinal vessel enhancement technique. The beauty of the work is single step brightness normalization and neighbourhood enhancement techniques are used.

In 2008, Multi scale line operation based blood vessel enhancement is suggested by Farnell, et al. The algorithm is based on different region growing techniques. Finally, the results are compared with median filtering techniques.

Retinal images based extraction techniques

In 2000, Hunter, et al. have worked on neural network based exudates detection. In this work, they provided a hierarchical feature selection algorithm. For feature selection, they used sensitivity analysis to distinguish the most significant features. They achieved 91% lesion-based performance using small number of images.

In 2000, Ege, et al, have employed the system which provides automatic analysis of digital fundus images. They used Bayesian, Mahalanobis, and k- nearest neighbour classifiers on 134 retinal images data set. Among these neural networks, the Mahalanobis classifier showed the best results. The accuracy of neural network for microaneurysms, haemorrhages, exudates, and cotton wool spots were detected with a sensitivity of 69%, 83%, 99%, and 80%, respectively.

In 2001,Gagnon, et al., proposed the geometric criteria regarding position of macula with respect to the optical disk. The method is faithful to find the precise centre of the macula by searching the darkest pixel in the image.

In 2005, for detection of the borders of macula in retinal image, adaptive thresholding based macular segmentation in OCT (Optical Coherence Tomography) is implemented by Hiroshi, et al. The drawback is that it is not suitable for low quality images.

In 2005, Hough transform is used for Optical Disk (OD) detection by Chrastek, et al. The extracted features of optical disk are used as inputs to the classifiers to identify glaucoma in retinal images. The work has highlighted the use of OD detection for classifying normal and the abnormal images. Experimentation was done only on low quality images.

In 2008, Neimeijer, et al, have incorporated the local vessel geometry and image intensity features of retinal image for optic disk detection in retinal images. K-NN classifier is then used to segment the optic disk from the retinal images. But the proposed method is not useful for low contrast images.

In 2006, Alan D. Fleming et al, proposed the green channel division of the original fundus image with the background intensity of the image. In the work multiple local contrast enhancement methods were tested to improve detection accuracy.

EXISTING SYSTEM

There are two important methods used for diagnosis of diabetic retinopathy. The methods are clinical eye examination and the eye fundus photography. The eye fundus retinal photography is the most easy and more accurate diagnostic tool for detection of diabetic retinopathy.

The clinical eye examination is used for the patients where retinal fundus photography facility is not available. Other alternate modalities,such as fluorescein angiography and optical coherence tomography (OCT), are utilized to support the eye examination. In critical cases, if the retina is out-of-the-way and light cannot pass through the eye, the condition of the retina can be inspected using ophthalmic ultrasound. Clinical Eye Examination The tool uses in clinical eye examination is of two types of ophthalmoscopes. One is direct and indirect ophthalmoscopes, and other is bio microscope with indirect lenses. A direct ophthalmoscope is a simply hand held apparatus through which an ophthalmologist can observe the patient's eye. In the indirect ophthalmoscopy, the patient's eye is examined with an arm's length apparatus by focusing high intensity light through a hand-held condensing lens to the patient's eye and examining the reflected light (stereoscopic image) with the binocular lenses. The bio microscope uses an observation system and an illumination system. The observation system of a bio microscope is capable of wide range of magnifications and the illumination system emits focal light into the patient's eye that can be controlled with slit mechanism and apertures.

Eye fundus retinal photography

Eye fundus retinal photography is considered the most perfect investigative mean for diagnosis of diabetic retinopathy. It produces the retinal images which are reliable, and easy to use. In opposite to the conventional ophthalmoscopy, retinal images allow to record analytical data and having more sensitivity rate of detection of abnormalities in retinal images.

Due to the rapid development in digital imaging field, the eye fundus cameras also provide easy ways to save the images in portable format that enable automatic diagnosis of diabetic retinopathy using various image analysis algorithms. Today retinal image analysis is one of the research area that is a focused by both scientists and surgeons. The main purpose of this research area is to develop the automated computational system which will support to diagnosis diabetic retinopathy in retinal images related to pathological and anatomical structures of the retina. The process of detection of diabetic retinopathy in retinal images and deciding its severity for further medical treatment is time consuming and repetitive. Digital imaging of the eye fundus and automated retinal image analysis algorithms provide a potential solution for such problems. By automating the diabetic retinopathy diagnosis process, more patients could be monitored in short time and if required, they can be referred for further medical treatments. In order to distinguish normal and abnormal retinal images, different techniques are used in the system which are able to identify the presence of different clinical signs present in abnormal images. In the literature, image processing techniques such as dynamic thresholding and matched filters have been applied to detect exudates. However, these techniques do not contain any recognition models that are able to distinguish between visually similar symptoms. Classification algorithms have also been utilized to distinguish between exudates and cotton wool spots, but the single classifier used is unable to maintain accuracy over a large images dataset. Also, many retina images are looking very similar but having difference with very subtle details. However, these differences have a great influence on clinical decisions. In current clinical practices, medical experts usually spend a much longer time to decide whether an image is indeed really normal or abnormal.

PROPOSED METHODOLOGY

A. COLOR FEATURE EXTRACTION

Color features include the conventional color histogram (CCH), the fuzzy color histogram (FCH), the color correlogram (CC) and a more recent color-shape-based feature. The extraction of the color-based features follows a similar progression in each of the four methods: Selection of the color space, quantization of the color space, extraction of the color feature, derivation of an appropriate distance function .

i. CONVENTIONAL COLOR HISTOGRAMS

The conventional color histogram (CCH) of an image indicates the frequency of occurrence of every color in an image. From a probabilistic perspective, it refers to the probability mass function of the image intensities which captures the intensities (joint probabilities) of the color channels (R, G and B in the RGB color space, or H, S and V in the HSV color-space, and similarly for other color spaces). The CCH can be represented as hA,B,C (a, b, c) = N . Prob(A=a, B=b, C=c), where A, B and C are the three color channels, and number of pixels is denoted by N in the image . Computationally, it is constructed by counting the number of pixels of each color (in the quantized color space).

ii. FUZZY COLOR HISTOGRAM

In the fuzzy color histogram (FCH) approach, a pixel color belongs to all histogram bins with different degrees of memberships to each bin. More formally, given a color space with K color bins, the FCH of an image I is defined as follows: F(I)=[f1 , f2 ,… fK]

$$f_i = \sum_{j=1}^{N} \mu_{ij} \, p_j = \frac{1}{N} \sum_{j=1}^{N} \mu_{ij}$$

Where N is number of pixels in an image, and µij is the membership value of the jth pixel in the ith color bin. The primary advantage of the FCH is that it encodes the degree of similarity of each pixel color to all other histogram bins through a fuzzy-set membership function (namely the µij). Taking into account color pixel similarity makes the

FCH more robust to quantization errors as well as to changes in light intensity . The FCH however, still embeds several drawbacks. Like the CCH, the FCH delineates only the global Color properties of the image, and the dimensionality of the FCH features is as high as that of the CCH. In addition, the FCH approach introduces the additional challenge of computing the appropriate fuzzy membership function µij .

iii. COLOR CORRELOGRAM

The color correlogram (CC) expresses how the spatial correlation of pairs of colors changes with distance. A CC for an image is defined as a table indexed by color pairs, where the dth entry for row (i,j) specifies the probability of finding a pixel of color j at a distance d from a pixel of color i in the image. The local correlations between different colors are more significant than global correlations in an image, special correlations can be captured with a small value of d. An efficient algorithm for computing the CC exists and is described . The computation is linear in the image size. CC method encodes local as well as global spatial information, and it work well for coarse color images. The disadvantage of this method is the high dimensionality of the feature space.

iv. COLOR-SHAPE BASED METHOD

CSBM (color-shape based method) based on color and shape (area and perimeter intercepted lengths)of the segmented objects in an image. The algorithm starts by clustering image pixels into K clusters according to the K-means algorithm. The mean value of each cluster is regarded as a representative color for the cluster. A quantized color image I’ is obtained from the original image I by quantizing pixel colors in the original image into K colors. Any connected region having identical color pixels is regarded as an object. Now area of each object is encoded as the number of pixels in the object. Further, the shape of an object is characterized by 'perimeter-intercepted lengths' (PILs), obtained by intercepting the object perimeter with eight line segments having eight different orientations and passing through the object center. The PILs have been shown to be a good characterization of object shapes. The immediate advantage of this method is that it encodes object shapes as well as colors. The drawback on the other hand, is more involved computation, and the need to determine appropriate color thresholds for the quantization of the colors. Another drawback of CSBM is its impressionability to contrast and noise variation

B. TEXTURE FEATURE EXTRACTION

Texture feature extraction methods include the steerable pyramid, the contourlet transform, the Gabor wavelet transform and the complex directional filter bank (CDFB).

i. THE STEERABLE PYRAMID

The steerable pyramid generates a multi-scale, multi-directional representation of the image. The basic filters are translations and rotations of a single function. The image is decomposed into one decimated low-pass sub-band and a set of undecimated directional sub-bands. The decomposition is iterated in the low-pass sub-band. Because the directional sub-bands are undecimated, there are 4K/3 times as many coefficients in the representation as the original image, where K is the number of orientations.

ii. CONTOURLET TRANSFORM

The contourlet transform provides a multi-scale, multi-directional decomposition of an image. It is a combination of a Laplacian pyramid and a directional filter bank (DFB). Bandpass images from the Laplacian pyramid are fed into the DFB so that directional information can be captured. After decimation, the decomposition is iterated using the same DFB. Its redundancy ratio is less than 4/3 because

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the directional sub-bands are also decimated.

iii. GABOR WAVELET TRANSFORM

To obtain a Gabor filter bank with K orientations and S scales, the two-dimensional Gabor function is dilated and rotated appropriately by setting the parameters of the Gabor function (thus obtaining K*S Gabor functions). The image is then convolved with each of the obtained Gabor functions. It has been shown that the Gabor Transform for texture image retrieval yields the highest texture retrieval results. However, it results in an over-complete representation of the original image with a redundant ratio of K*S.

iv. COMPLEX DIRECTIONAL FILTER BANK

The shift-invariant complex directional filter bank (CDFB) has recently been proposed. The transform consists of a Laplacian pyramid and a pair of DFBs, designated as primal and dual filter banks. The filters of these filer banks are designed to have special phase functions so that the overall filter is the Hilbert transform of the primal filter bank. A multi-resolution

representation is obtained by reiterating the decomposition at the low pass branch. Shift invariance, comparably high texture retrieval performance and relatively low redundancy ratio are some of the special features of CDFB.

C. SHAPE FEATURE EXTRACTION

In image retrieval, as per applications, shape representation are required to be either invariant to translation, rotation, and scaling or not. Hence, two categories of shape representations can be distinguished, boundary and region based. The first utilizes only the outer boundary of the shape while the other access the entire shape region . The most successful representatives for these two categories are Fourier descriptor and moment invariants. The main idea of a Fourier descriptor is to use the Fourier

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transformed boundary as the shape feature proposed a modified Fourier descriptor which is both robust to noise and invariant to geometric transformations . The main idea of moment invariants is to use region-based moments which are invariant to transformations, as the shape feature. In seven such moments Many improved versions emerged based on those like proposed a fast method of computing moments in binary images based on the discrete version of Green's theorem . Also developed algorithms to systematically generate and search for a given geometry's invariants.Gross and Latecki developed an approach which preserved the qualitative differential geometry of the object boundary, even after an image was digitized. In, a framework of algebraic curves and invariants is proposed to represent complex objects in a cluttered scene by parts or patches. Polynomial fitting is done to represent local geometric information, from which geometric invariants are used in object matching and recognition. Some recent work in shape representation and matching includes the finite element method (FEM) , the turning function , and the wavelet descriptor . The FEM defines a stiffness matrix which describes how each point on the object is connected to the other points. Modes are the eigenvectors of the stiffness matrix while span of the eigen vector is called a feature space developed a turning function-based method for comparing both convex and concave polygons along a similar line of the Fourier descriptor. In used the wavelet transform to describe object shape. Some recent review papers in shape representations are showed that the geometric moments method (region-based) and the Fourier descriptor (boundary-based) were related by a simple linear transformation. In compared the performance of boundary-based representations, region- based representations and combined representations. Their experiments showed that the combined representations outperformed the simple representations. There were many methods developed for 3D shape representations as

presented a technique for normalizing Fourier descriptors which retained all shape information and was computationally efficient. They also took advantage of an interpolation property of Fourier descriptor which resulted in efficient representation of 3D shapes. In the proposed using a hybrid structural/statistical local shape analysis algorithm for 3D shape representation. Further proposed using a set of algebraic moment invariants to represent both 2D and 3D shapes , which greatly reduced the computation required for shape matching.

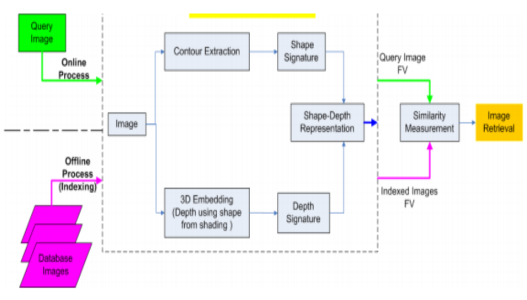

Fig.1. proposed system model.

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.

$$D(T,Q) = \sum_{i=1}^{K} \left| \frac{T_i - Q_i}{1 + T_i + Q_i} \right|$$

For the proposed method, K=90 for all the images. A smaller $D(T, Q)$ means more similar to the query image. In our experiments, we use the precision and recall curves that commonly used in content based image retrieval. The precision and recall is defined The precision of P is defined as ratio between the number of the retrieved relevant images I N and the total number of the retrieved images N; it measures the accuracy of the retrieval. Recall R is defined as ratio between the number of the retrieved relevant images I N and the total number of the relevant images M of the whole dataset; it measures the

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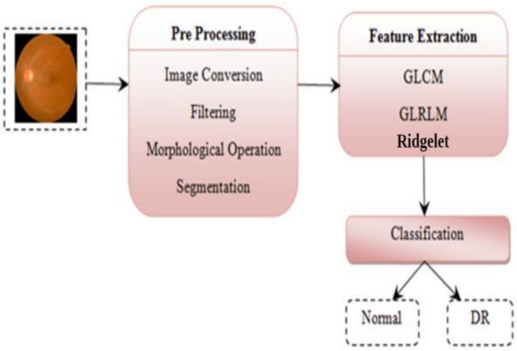
robustness of the retrieval. In our image retrieval method, N=12 and M=100. Obviously, the quantization number of color and edge orientation all have direct influence on the formation of image feature in according to the description. So different quantization numbers for color and edge orientation are used to test the performance of the proposed method (with 2×2=4 sub-blocks and =0.5) in the L*a*b*, RGB and HSV color spaces. The values of precision and recall with the top 12 matches are listed in Tables 1-3. From these data, we can see that the RGB color space is more suitable for our method than the other two color spaces. When the quantization numbers for color and edge orientation are 128 and 30 respectively, the precision of our method is 65.90%. When the quantization number for color is increased to 6×6×6=216, the performance of our method is reduced, because as the color quantization number is increased, too many noisy features may be obtained, which will not enhance the description power. So we select the RGB color space with 128 and 30 quantization numbers for color and edge orientation respectively in this paper, then a 632-dimensional feature vector is extracted for every image in the retrieval image datasets.

Table 1 The average retrieval precision and recall results on two datasets

Dataset	Performance	Method		
		MTH	MSD	TSH
Corel_5000	Precision(%)	52.12	55.92	60.47
	Recall(%)	6.25	6.71	7.26
Corel_10000	Precision(%)	39.1	45.62	47.24
	Recall(%)	4.69	5.48	5.67

For analysis the influences of color histogram feature and edge orientation feature on retrieval performance, we experiment with different in distance metric is ranged from 0 to 1 by step 0.1. The case of only using edge orientation histogram feature is corresponding to 1, and the color histogram feature case is for 0.



It can be seen from that for most nationalities, the performance rise first and descend latter when changes from 0 to 1, which means the effective fusion of both types of feature can improve the retrieval performance. We also find out that for most nationalities, the performance rise sharply first and become gently later, which means color histogram feature play a crucial role in the integrated feature. However, for Jingpo nationality and Hani nationality, the performance rise so gently that they lose to Bai nationality and Bouyei nationality whose performance is worse than them when only using edge orientation histogram feature.

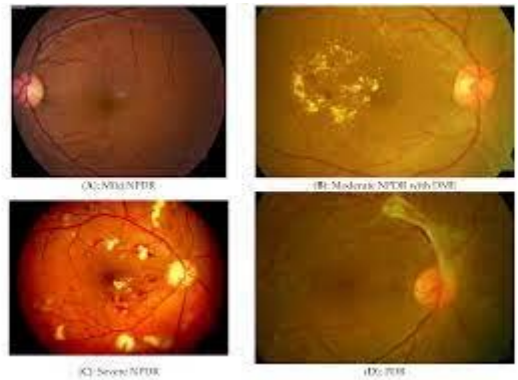


Fig.1. output results.

This indicates that the color histogram feature seems to have little effect on Jingpo nationality and Hani nationality, because the dominant color of Jingpo nationality and Hani nationality are so similar that they infect each other, pulling down their precision. To test the effect of the number of sub-blocks on retrieval performance, we experiment with different numbers (2×2=4, 3×3=9 and 4×4=16) of sub-blocks and compare them with the undivided case. The results in the Table 4 show that when the number of sub-blocks is 2×2=4, we obtain the highest precision and recall with □=0.4, and the precision is improved by almost 4 percentage points compared to the undivided situation. When the number of sub-blocks

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increases, the precision and recall of edge orientation histogram feature increases, but the precision and recall of color histogram feature reduces, and because the color feature is the most important feature of retrieval image, the precision and recall of comprehensive feature reduces.

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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