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Diabetic Haemorrhage Detection using DWT and Elliptical LBP

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Abstract - *The extraction of exact retinal haemorrhage of diabetic patient plays a significant role in medical image processing. This paper presents an accession for detection of both haemorrhage and healthy retina using symmetric Elliptical Local Binary Pattern (ELBP) and Discrete Wavelet Transform (DWT). The features of both haemorrhage and healthy retinal images are extracted using ELBP and further features are reduced by DWT. For classification binary SVM classifier is used here. The approach implemented on HRF database signifies 92.3% rate of accuracy.*

Key Words: DWT, Elliptical Local Binary Pattern, SVM, Diabetic haemorrhage

1. INTRODUCTION

Diabetic retinopathy is one of the paramount topics in the field of medical research. In recent times, automatic tracking down of haemorrhages in diabetic retinal images has become immensely important in the clinical milieu. Indeed, diabetic retinopathy is a disease that deteriorates the retina and can lead to blindness. Haemorrhages in the retina are one of the primeval symptoms of diabetic retinopathy. An early and accurate diagnosis of diabetic retinopathy helps to improve medical treatment and prognosis. To abetment ophthalmologists numerous computer-sustain interpretation setup have been proposed in identifying diabetic retinopathy by detecting exudates, micro-aneurysms, or hemorrhages in the retina.

In Ref. [1], the authors contemplated an automated methodology by extracting fovea, retinal tissue and optic disc in order to segment dark spot lesions. Then, those segmented spots are classified into micro-aneurysms and hemorrhages. In Ref. [2], the authors contemplated three stage automated methodology to detect exudates and macula. Exudates derivation is conceivably imitate in first lap by a distinct number of features. Macula is identified in second lap by a GMM (Gaussian mixtures model) classifier trained with accomplish features. Lastly, to categorized diabetic macular edema the macular conform and section of exudates are assigned.

In Ref. [3], the authors conferred a methodology hinge on by extracting regions of interest and normalizing local-maxima scale for micro-aneurysm revelation. For portraying goals Hessian response are assigned across different scales. Finally, to disclose regions with true micro-aneurysm four classifiers: Naïve Bayes, Support Vector Machines (SVM) random forest and K-Nearest Neighbor (K-NN) are employed with scale-space features. In Ref. [4], a three- step set up was conferred for revelation of micro-aneurysms by proving filter banks. Firstly whole expedient applicant portion are tabbed for micro-aneurysms. Then, a sort of features is enumerating for each division in the second stage. Finally, a GMM (Gaussian mixture model) and SVM (Support Vector Machine) are combined to perform classification. Moreover in Ref. [5], the authors conferred a methodology for revealing of micro-aneurysms by proving a sparse representation and dictionary learning. In their effort, vicinity with presumed micro-aneurysms is distinguished by proving multi-scale Gaussian correlation filter. At the end most steps Support Vector Machine (SVM) is being employed for training as well as classification.

2. PROPOSED METHODOLOGY

Our proposed methodology mainly comprises of Pre-processing, Feature extraction, Feature reduction and Classification. The overall block diagram of our proposed method as follows:

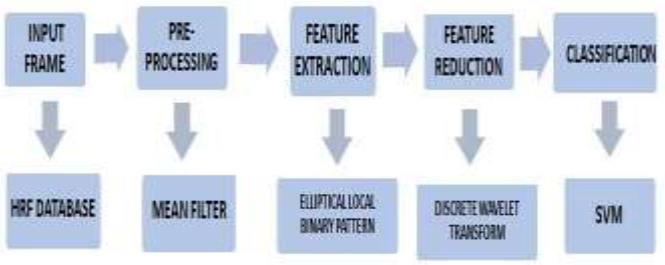

Figure 1: Block Diagram of Proposed Methodology

2.1 PRE-PROCESSING

Retinal image can be represented by combination of small-scale (high frequency) and large scale (low frequency) features. Illumination variations deeply affect on a large scale i.e. low frequency features. So it is an important step to correct the illumination affects of the retinal images before extracting their features. In our approach we apply mean or averaging filter of mask 5×5 to correct the illumination.

2.2 ELLIPTICAL LOCAL BINARY PATTERN

ELBP [7] is just a modified version of general Local Binary pattern(LBP). The original LBP [8] imported by Ojala et al. to form the labels of an image by thresholding 3x3 neighborhood each pixels with the center pixel value. In ELBP scheme ellipse is considered rather than circle. ELBP code is computed by comparing its value with surrounding which are located on an ellipse and the center of the ellipse is current pixel itself. If R1 and R2 are horizontal and vertical radius of the ellipse then ELBP level for one pixel (x_c,y_c) surrounding with K neighboring pixel is:

$$ELBP^{K,R1,R2}(x_c,y_c) = \sum_{i=1}^{K} S(g_i^{K,R1,R2} - g_c)\, 2^{i-1}$$

Where g_c and g_i are the gray scale value of current and the ith neighboring pixels. The binary encoding function S(x) is defined as follows:

$$S(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases}$$

If R1 > R2 then it is horizontal ELBP (hELBP) and if R2 > R1 then it is vertical ELBP (vELBP). In our work we have considered both 3 × 5 horizontal and 5 × 3 vertical ELBP to get 5×5 symmetric ELBP mask for feature extraction. The symmetric ELBP pair is as follows:

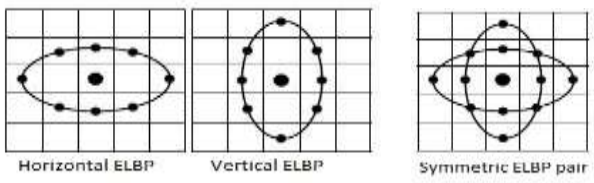

Figure 2: 5x5 Symmetric ELBP Pair

We applied symmetric ELBP mask of 5×5 on entire illumination corrected retinal image to derive the micro features.

2.3 DISCRETE WAVELET TRANSFORM

DWT [6] is a discretely sampled wavelet transform capable of capture both frequency and time domain information. DWT decompose the signal into different bands or frequency. The involve filters of DWT are known as 'wavelet filter' and 'scaling filter'. The wavelet filter is high pass filter and other is low pass filter. DWT performs on different mother wavelets such as Haar wavelet, Daubechies, Morlet and others.

In image processing 2D-DWT is employed which perform operation throughout the rows of original image by employing both low pass filter (LPF) and high pass filter (HPF) simultaneously. Then down sampled by factor 2 and achieved detailed part (high frequency) and approximation part (low frequency). Further operation is performed throughout the columns of image. At every level four sub images are achieved. Among them one is approximate image (LL) and other three are vertical (LH), horizontal (HL) and diagonal detail (HH).

In our work we computed 1st level 2D-DWT on ELBP extracted features to decompose it into four sub bands. Among them we took approximate (LL) band of the features and other three were discarded. We considered 'Haar' wavelet as mother wavelet in our approach.

2.4 SUPPORT VECTOR MACHINE

Support Vector Machine [9] finds wide applications in the field of pattern recognitions. In separating the various classes, the SVM achieves a separation level which is near optimum. In our study, by using the extracted features we train the SVM to perform the classification of the facial expression. The SVM, in general, separates the high-dimensional space by building a hyperplane. As the distance between the training data of any of the classes and the hyper plane is the largest, it is termed as the ideal separation. Given labelled samples of a training set:

$$D = (X_i, y_i) | x_i \in \{-1, 1\}_{i=1}^{p}$$

The SVM tries to acquire a hyper plane that distinguishes the samples having the smallest errors.

$$w.x - b = 0$$

For x_i an input vector, the classification process is achieved by evaluating the distance from xi, the input vector to the hyper plane. The actual SVM is a binary classifier. However, for performing the multi-class classification, here we take the one-against-rest strategy.

3. RESULTS AND DISCUSSION

For appraising our proposed system, we made utilization of High-Resolution Fundus (HRF) database [10]. The database comprises images of 15 fit patients, 15 diabetic haemorrhages patients and 15 glaucomatous patients. The images here are resized to 300×200. When the input image is fed, at first, we apply the 5×5 mean filter. Subsequently the techniques of the proposed method are applied for acquiring the features. We selected randomly both healthy and haemorrhage retina images to create training and testing set. Finally training and testing set consist of 23 and 13 images respectively.

Figure 3: Accuracy Plot of HRF database

The confusion matrix plot of HRF database is shown in Figure 3, hereby we have achieved 92.3 rate of accuracy.

4. CONCLUSION

We propose an effective method in this paper to handle the problem of retinopathy for exact detection of haemorrhage retina in different lighting conditions (illumination variation). Human eyess are elliptical in nature hence we have applied a texture based elliptical LBP pair on retinal image to derive more exact micro components of retina. Moreover DWT was also computed to reduce feature without losing important information and reduce computation time. The features are then classified by using SVM classifier. Experimental results on the HRF database signifies that the contemplated methodology achieves a significantly better accuracy rate being 92.3%. The task of detection of the haemorrhage retina is very exacting. More efforts to improve the detection rate are to be required for vital applications. Our future work objective is improving the performance accuracy of the method in the wild and also in the blur retinal images.

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