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Automated Analysis of Microaneurysm Detection of Diabetic Retinopathy

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ABSTRACT

When sugar level (glucose) in the blood fails to regulate the insulin properly in human body, diabetic is occurred. The effect of diabetic on eye causes Diabetic Retinopathy. Diabetic Retinopathy is one of complicated diabetes which can cause blindness. It is metabolic disordered patients perceive no symptoms until the disease is at last stage. So early detection and proper treatment has to be ensured. To serve this purpose, various automated systems have been designed. A key feature to recognize Diabetic Retinopathy is to detect micro aneurysm in the fundus of the eye. There are 2 levels of Diabetic Retinopathy which are non proliferative Diabetic Retinopathy (NPDR) and proliferative Diabetic Retinopathy (PDR). To automatically detect both microaneurysms and hemorrhages in color fundus images, which are among the very first manifestation of Diabetic Retinopathy screening.

KEYWORDS: *Diabetic Retinopathy, Non Proliferative Diabetic Retinopathy (NPDR) , Proliferative Diabetic Retinopathy (PDR).*

I. INTRODUCTION

Image processing is a physical process used to convert an image signal into a physical image. The image signal can be either digital or analog. The actual output itself can be an actual physical image or the characteristics of an image. The most common type of image processing is photography. In this process, an image is captured or scans using a camera to create a digital or analog image. In order to produce a physical picture, the image is processed using the appropriate technology based on the input source type. In digital photography, the image is stored as a computer file. This file is translated using photographic software to generate an actual image.

A. Diabetic retinopathy:

It is an ocular manifestation of diabetes, a systemic disease, which affects up to 80 percent of all patients who have had diabetes for 20 years or more. Despite these intimidating statistics, research indicates that at least 90% of these new cases could be reduced if there were proper and vigilant treatment and monitoring of the eyes. The longer a person has diabetes, the higher his or her chances of developing diabetic retinopathy. Each year in the United States, diabetic retinopathy accounts for 12% of all new cases of blindness. It is also the leading cause of blindness for people aged 20 to 64 years.

Diabetic retinopathy (DR) is a vascular disease of the retina which affects patients with diabetes mellitus. It is the number one cause of blindness in people between the ages of 20-64 in the United States. It is, therefore, a worthwhile topic for all medical students to review. Diabetes mellitus is extremely common, so it is not surprising that DR affects 3.4 percent of the population (4.1 million

individuals). Of the millions of people with DR, nearly one-fourth have vision-threatening disease (AAO 2008).

The likelihood of developing diabetic retinopathy is related to the duration of the disease. Type 2 diabetes has an insidious onset and can go unnoticed for years. As a result, patients may already have DR at the time of diagnosis. Type 1 diabetics, on the other hand, are diagnosed early in the course of their disease, and they typically do not develop retinopathy until years after the diagnosis is made. The risk of developing retinopathy increases after puberty. Twenty years after the diagnosis of diabetes, 80% of type 2 diabetics and nearly all type 1 diabetics show some signs of retinopathy (Klein 1984a, Klein 1984b).

B. Anatomy:

The retina is a multi-layered sheet composed of neurons, photoreceptors, and support cells. It is one of the most metabolically active organs in the body, and as a result, it is extremely sensitive to ischemia and nutrient imbalances (Frank 2004). A perfused retina is a happy retina. The outer one-third of the retina receives its blood supply from the choriocapillaris, a vascular network that lies between the retina and sclera. The inner two-thirds of the retina are supplied by branches of the central retinal artery, which comes from the ophthalmic artery (the first branch off of the internal carotid artery.

II. LITERATURE SURVEY

1. Fully automated comparative micro aneurysm digital detection system

A fully automated digital image processing system, which provides an objective and repeatable way to quantify micro aneurysms in digitized fluoresce in angiograms, has been developed. The automated computer processing includes registration of same-eye retinal images for serial studies, cutting of regions-of-interest centered on the fovea, the detection of micro aneurysms and the comparison of serial images for micro aneurysm turnover. The micro aneurysm detector was trained against a database of 68 images of patients with diabetes containing 394 true micro aneurysms, as identified by an ophthalmologist. The micro aneurysm detector achieved 82% sensitivity with 2.0 false-positives per image. An independent test set, comprising 20 images containing 297 true micro aneurysms, was used to compare the micro aneurysm detector with clinicians.

Techniques used:

- Micro aneurysm detector
- The advantage of the computer system includes objectivity, repeatability, speed and full automation.
- Demerits:
- Poor photographic quality
- The monitoring of diabetic retinopathy requires a serial study of each patient-eye, and this issue has not been addressed.

2. A comparison of computer based classification methods applied to the detection of micro aneurysms in ophthalmic Fluorescein angiograms

We compared the performance of three computer based classification methods when applied to the problem of detecting micro aneurysms on digitized angiographic images of the retina. An automated image processing system segmented `candidate' objects (micro aneurysms or spurious objects), and produced a list of features on each candidate for use by the classifiers. We compared an empirically derived rule based system with two automated methods, linear Discriminant analysis and a learning vector quantiser artificial neural network, to classify the objects as micro aneurysms or otherwise. ROC analysis shows that the rule based system gave a higher performance than the other methods although a much greater development time is required.

Techniques used: Classification methods

- An empirically-derived quantitative and logical rule-base (RBS).
- Linear discriminant analysis (LDA).

3. A Learning vector quantiser (LVQ) artificial neural network (ANN).

Each classifier was trained on the training set, and then tested against the test set in the specified manner.

Demerits:

- The appearance of micro aneurysms can deviate from the classical description.
- Low sensitivity
- Low accuracy output

3. Automatic detection of micro aneurysms in color fundus images

This paper addresses the automatic detection of micro aneurysms in color fundus images, which plays a key role in computer assisted diagnosis of diabetic retinopathy, a serious and frequent eye disease. The algorithm can be divided into four steps. The first step consists in image enhancement, shade correction and image normalization of the green channel. The second step aims at detecting candidates, i.e. all patterns possibly corresponding to MA, which is achieved by diameter closing and an automatic threshold scheme. Then, features are extracted, which are used in the last step to automatically classify candidates into real MA and other objects; the classification relies on kernel density estimation with variable bandwidth.

Techniques used:

- Computer assisted diagnosis of DR
- It addresses the automatic detection of micro naneurysms in color fundus images, which plays a key role in computer assisted diagnosis of diabetic retinopathy, a serious and frequent eye disease.

Demerits:

- Fluoresce in angiographies (FA) allows detection of MA with a greater sensitivity; they are invasive and costly and therefore not adapted for screening purpose.

4. Retinal Micro aneurysm Detection Through Local Rotating Cross-Section Profile Analysis

A method for the automatic detection of microaneurysms (MAs) in color retinal images is proposed in this paper. The recognition of MAs is an essential step in the diagnosis and grading of diabetic retinopathy. The proposed method realizes MA detection through the analysis of directional cross-section profiles centered on the local maximum pixels of the preprocessed image. Peak detection is applied on each profile, and a set of attributes regarding the size, height, and shape of the peak are calculated subsequently. The statistical measures of these attribute values as the orientation of the cross-section changes constitute the feature set that is used in a naïve Bayes classification to exclude spurious candidates. We give a formula for the final score of the remaining candidates, which can be thresholded further for a binary output. The proposed method has been tested in the Retinopathy Online Challenge, where it proved to be competitive with the state-of-the-art approaches.

Techniques used:

- Retinal micro aneurysm detection
- A method for the automatic detection of micro aneurysms (MAs) in color retinal images is used.

Demerits:

- It did not apply any additional vessel or optic disk detection step.
- Output having some noises and require different preprocessing

5. Detection of micro aneurysms using multi-scale correlation coefficients

This paper presents a new approach common and severe complication of long-term diabetes which damages the retina and cause blindness. Since micro aneurysms are regarded as the first signs of DR, there has been extensive research on effective detection and localization of these abnormalities in retinal images. In contrast to existing algorithms, a new approach based on multi-scale correlation filtering (MSCF) and dynamic thresholding is developed. This consists of two levels, micro aneurysm candidate detection (coarse level) and true micro aneurysm classification (fine level).

Techniques used:

- Micro aneurysms detection using MSCF
- It presents a new approach to the computer aided diagnosis (CAD) of diabetic retinopathy (DR)—a common and severe complication of long-term diabetes which damages the retina and cause blindness.

Demerits:

It is very difficult to detect microaneurysms by classifying hemorrhages because their pixel values are similar to that of pixel values.

III. EXISTING SYSTEM

Thresholding and morphological operations are used for micro aneurysms detection from fundus images. In the first step, optic disk and blood vessels are eliminated to facilitate the detection of

MA. Secondly, the candidate features are extracted based on their size. Most MA detectors tackle the problem of classifying MA's in the following way: first the green channel of the fundus image is extracted and preprocessed to enhance MA like characteristics.Then, in a coarse level step (which will be referred as candidate's extraction), all MA-like objects are detected in the image.

Our former investigations showed that the low sensitivity of MA detectors originates from the candidate extractor part.The automated identification of exudates pathologies in retinopathy fundus images based on computational intelligence technique.The algorithm we developed is based on a sequential execution of morphological operators as well as machine learning technique. As SVM being a supervised classifier the drawback is the need for (manually) marked training information.

Disadvantages:

- All MA like objects are misclassified since it is hard to distinguish.
- Less accuracy for detection

IV. PROPOSED WORK

The dynamic shape features method is proposed for the detection of both MAs and HEs that does not require prior vessel segmentation.The proposed method takes as input a color fundus image together with the binary mask of its region of interest (ROI). The ROI is the circular area surrounded by a black background. It outputs a probability color map for red lesion detection. The method comprises six steps.

A. Spatial Calibration

To adapt to different image resolutions, we use a spatial calibration method introduced. Images are not resized. Rather, the diameter of the ROI (after removal of the dark background) is taken as a size invariant.

B. Image Preprocessing

The illumination of the retina is often nonuniform, leading to local luminosity and contrast variation. Lesions may be hardly visible in areas of poor contrast and/or low brightness. Consequently, preprocessing steps are required to address these issues

- Illumination Equalization
- Denoising
- Adaptive Contrast Equalization
- Color Normalization

C. Optic Disc Removal

The OD is a significant source of false positives in red lesion detection; therefore its removal is a necessary step.

D. Candidate Extraction

Since blood vessels and dark lesions have the highest contrast in the green channel, the latter is extracted from the preprocessed image. The candidate regions corresponding to potential lesions are identified in the preprocessed image, based on their intensity and contrast.

E. Dynamic Shape Features

The DSF together with color features are extracted for each candidate. To discriminate between these vessel segments, remaining noise and true lesions, an original set of features, the DSFs, mainly based on shape information, is proposed.

F. Classification

To distinguish between lesions and non-lesions, we use a Random Forest (RF) classifier. The Classified output shows the stages of the eye vision.

G. Advantages:

- Accurate detection
- High grading performance
- Disease level of patient can be monitored

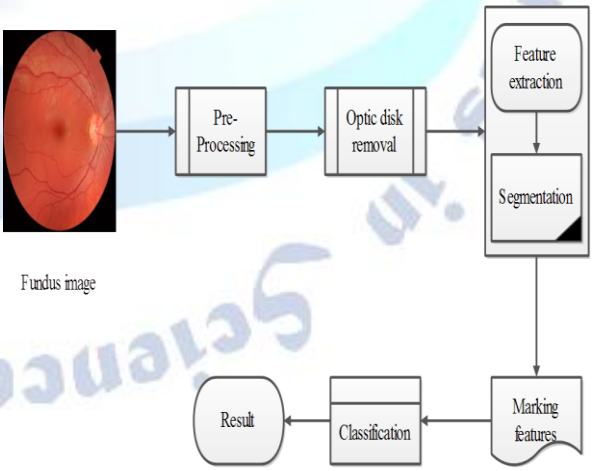

Fig 1 Over all flow of retinagraphy

V. RED LESION TECHNIQUES

A. Pre-Processing

In this module, the retinal image is given as an input.

The pre-processing algorithms are applied for
- Illumination Equalization
- Denoising
- Adaptive Contrast Equalization
- Color Normalization

B. Color normalization

It is necessary in order to obtain images with a standardized color range. The contrast drift is approximated using the local standard deviation computed for each pixel in a neighborhood of diameter, for each color channel.
Mean filter is used to reduce the noise.

C. Optic Disk Removal

The OD is a significant source of false positives in red lesion detection; therefore its removal is a necessary step.
Starting from the preprocessed image, we first use an entropy-based approach to estimate the location of the OD's center.

D. Feature extraction

To discriminate between these false positives and true lesions, an original set of features, the DSFs, mainly based on shape information, is used. The features based on size and shape is extracted using segmentation. The outlined features are identified using coarse segmentation. The fine segmentation used to extract fine Lesions.

E. Classification result

The extracted features are processed and classified as the final result. The expected output is the condition of the patient.
Normal, Mild, Moderate or Severe

VI. Conclusion

A novel red lesion detection method based on a new set of shape features, the DSFs, was presented and evaluated on six different databases. The results demonstrate the strong performance of the proposed method in detecting both MAs and HEs in fundus images of different resolution and quality and from different acquisition systems. The method outperforms many state-of-the-art approaches at both per-lesion and per-image levels. DSFs have proven to be robust features, highly capable of discriminating between lesions and vessel segments. The concept of DSFs could be exploited in other applications, particularly when the objects to be detected do not show clear boundaries and are difficult to segment precisely.

A. Experimental Results

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