Diabetic Retinopathy Screening (DRS)

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Abstract - ***The robust detection of red lesions in digital color fundus images is a critical step in the development of automated screening systems for diabetic retinopathy. Diabetic retinopathy is damage to the retina of human eye which is caused by the complication of increase in blood glucose level which can eventually leads to blindness. The longer the patient has diabetes the higher the chance of developing diabetic retinopathy. In this paper, we introduce a novel method for automatic detection of red lesion in retinal images using dynamic shape features. Dynamic shape features is defined as new set of shape features. These features represent the evolution of the shape during image flooding and allow discriminating between lesions and vessel segments using watershed segmentation.***

Key Words: **Diabetic retinopathy, lesion detection, retina, dynamic shape feature**

1.INTRODUCTION

Image processing is a process of converting an image into digital form and performs some operations on it, in order to get an enhanced image or to extract some useful information from it. The input for this method is image, like video frame or photograph and output may be image or characteristics associated with that image.

Image processing system includes treating images as two dimensional signals while applying already set signal processing methods to them. It is among rapidly growing technologies today, with its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines.

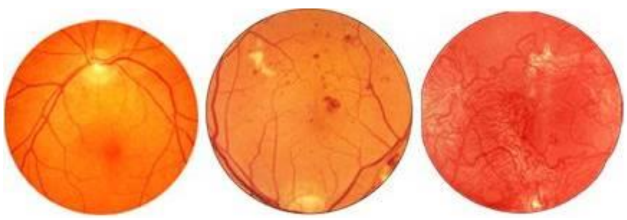
Diabetic Retinopathy (DR) is an abnormality of the eye in which the human retina is affected due to an increasing amount of insulin in the blood [2]. Detection and diagnosis of DR at the early stage helps to save the vision of diabetic patients. The early signs of DR that may cause vision impairment which appear on the surface of retina are microaneurysms, haemorrhages, and exudates. DR is the primary cause of blindness in America and over 99% of cases in India. India and China currently account for over 90 million diabetic patients and are on the average of an explosion of diabetic populations. This may result in an unprecedented number of persons becoming blind unless diabetic retinopathy can be detected early.

The International Diabetes Foundation reports that India has the largest share of population leading to blindness with over 50 million people and growing rapidly [3]. The leading cause of blindness is Diabetic retinopathy in adults around the world today. Health care costs motivated by diabetes are also increasing around the world.

The conventional methods, such as dilating the eye pupil, take time and make patients suffer for a while. Whereas, Biomedical applications such as, automated retinal image analysis made the detection of retinal pathologies much easier for ophthalmologists. Diabetic Retinopathy (DR) is caused by the damage to blood vessels of the retina[4]. It occurs when high blood glucose, the characteristic of diabetes, has damaged the small vessels that provide oxygen and nutrients to the retina.

There are two stages in DR Non-proliferative and proliferative diabetic retinopathy. The first stage which is called *non-proliferative diabetic retinopathy* (NPDR) there are no symptoms of vision impairment, the signs are not visible to the eye and patients will have 20/20 vision it is hard to identify impairment. The only way to detect NPDR is by photography, in which microaneurysms can be seen.

In the second stage, abnormal new blood vessels form at the back of the eye as part of *proliferative diabetic retinopathy* (PDR); these can burst and blur the vision, because these new blood vessels are fragile. At the initial stage when bleeding occurs for the first time, it may not be very severe. In most of the cases, it may just leave few specks of blood, or spots floating in a person's visual field, and these spot may disappear after few hours. These spots are often followed within a few days or weeks by a much greater leakage of blood, which blurs the vision.



Normal Eye Non-*proliferative* Eye *Proliferative* Eye

In extreme cases, a person may only be able to tell the forms of light in dark. It may take few days months or even years to clear the blood from blood vessels inside the eyes, and in some cases the it may not be possible to clear the blood. These types of large hemorrhages tend to happen more than once, often during sleep.

A computer-aided screening and grading system relies on the automatic detection of lesions. Fundus images with DR exhibit red lesions, such as microaneurysms (MA) and hemorrhages (HE), and bright lesions, such as exudates and cotton wool spots.

Since computer analysis cannot replace the clinician, the system aims at identifying fundus images with suspected lesions and at sorting them by severity. Then, the annotated images are sent to a human expert for review, starting with the suspected most severe cases. Such an automatic system can help to reduce the specialist's burden and examination time, with the additional advantages of objectivity and reproducibility.

2. EXISTING SYSTEM

Hemorrhages (HE) are heavy discharge of blood from the blood vessels. A microaneurysm (MA) is a tiny aneurysm, or swelling, in the side of a blood vessel. In people with diabetes, microaneurysms are sometimes found in the retina of the eye. These miniature aneurysms can rupture and leak blood. A common methodology is adopted for detecting combined MA and HE, it identifies all dark-colored structures in the image, mainly through thresholding, combined with preprocessing and then removing the vessels from the resulting set of candidates.

The major limitation to this approach is that most of the false positives results occur at the vessel segmentation step. After image preprocessing, candidate regions are identified. Features are then extracted and used to classify each candidate. The candidate regions are first segmented; then, color and shape features are extracted and used for classification. However, the reliability of the color and shape features depends greatly on the accuracy of the segmentation step. High accuracy is difficult to obtain, particularly in low resolution images.

3. PROPOSED SYSTEM

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.

First, spatial calibration is applied to support different image resolutions. Second, the input image is preprocessed via smoothing and normalization. Third, the optic disc (OD) is automatically detected, to discard this area from the lesion detection. Fourth, candidate regions corresponding to potential lesions, are identified in the preprocessed image, based on their intensity and contrast. Fifth, the DSF together with color features are extracted for each candidate. Sixth, candidates are classified according to their probability of being actual red lesions. Each of these steps is detailed in the following subsections.

A. Spatial calibration

Spatial calibration refers the process of correlating the pixels of an acquired image to real features in the image. This process can be used to make accurate measurements in real-world units (instead of pixels), and to correct for camera perspective and lens distortion.

Three levels of spatial calibration provide the capability to correct various types of distortions in images. A simple calibration assumes the camera is perpendicular to and far away from a scene, so perspective and lens distortion is negligible. It can compensate for non-square pixel sizes and convert pixels to real-world coordinates. A perspective calibration corrects for effects arising from the camera viewing the scene from an angle, and applies a linear correction based on the geometry of the situation.

B. Image Preprocessing

The illumination of the retina is often non-uniform, leading to contrast variation. Lesions may be hardly visible in areas of poor contrast and/or low brightness. The RGB to Grayscale conversion is done to increase the dynamic range of the image. Also, the retinal features can be analyzed much easily using the grayscale form of the image.

B. Optic Disc Removal

Although the optic disc has well-defined features and characteristics, localizing the optic disc automatically in a robust manner is not a straight-forward process, since the appearance of the optic disc may very significantly due to retinal pathologies. Sometimes the whole optic disc is brighter than the surrounding area.

C. Candidate Extraction

Microaneurysms (MAs) are small red spots which are the first pathological signs of diabetic retinopathy and appear at the earliest stage of this diabetic complication. MAs are caused by dilatation of thin retinal blood vessel. As the disease progress, the weakened walls of MAs or thin blood vessel may rupture and produce dot hemorrhages and later blot hemorrhages which are the next pathological signs of diabetic retinopathy.

D. Dynamic Shape Features

It starts from an initial set of measured data and builds derived values intended to be informative and non-redundant, facilitating and subsequent learning and generalization steps, and some cases leading to better human interpretations. Shape features are related to dimensionality reduction.

Shape features involve reducing the amount of resources required to describe a large set of data [1]. When performing analysis of complex data one of the major problems stems from the number of variables involved. Analysis with a large number of variables generally requires a large amount of memory and computation power, also it may cause a classification algorithm to over fit to training samples and generalize poorly to new samples.

E. Classification

The classification of DR falls into two main classes: Non-proliferative (Normal blood vessels) and proliferative (Abnormal blood vessel growth) and the proliferative diabetic retinopathy can be further classified based on the severity of the blood leakage or damaged caused in the blood vessels which helps in the detection of diabetics level of patients. Depending upon these levels (Severe, Mild ,Moderate) the sugar level that came vision impairment can be detected and diagnosed.

4. IMPLEMENTATION

A. Image Acquisition:

Retinal image of the patients is acquired from gallery that is required for the further processing.

B. Preprocessing:

The objective of the preprocessing phase is to apply possible image enhancement techniques to obtain the required visual quality of the ultrasound images.

Image enhancement techniques,

1. Grayscale Image
2. Filtered Image
3. Histogram Equalization Image

1. Grayscale Image:

The ultrasound image is in RGB type which is an additive color of red, green, and blue. The image is converted into gray scale image for further processing.

2. Filtered Image:

A median filter does a very good job at reducing the noise in image.

3. Histogram Equalization Image:

The contrast enhancement of the image can be observed by applying histeq (enhance contrast using histogram equalization).

C. Segmentation:

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.

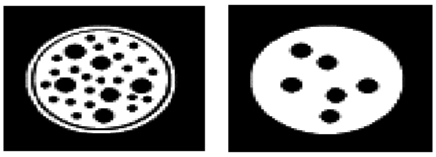
1. Morphological Operation
2. Thresholding Method

Morphological Operation:

Morphology is a technique for extracting the information from an image which is representation and description of region shape [4]. In our paper morphological operations are used in post processing mainly as a filter. Its fundamental operations are Boundary pixels and low frequency pixels are eliminated from image. Then difference image was generated.

<u>Erosion</u>: it shrinks objects in the binary image.

<u>Dilation</u>: grows or thickens the objects in binary image.



Morphological Process

Thresholding Method:

After, Thresholding is employed to segment red lesions in retinal images. Thresholding makes it possible to highlight pixels in an image.

Thresholding can be applied to gray scale images or color images. In this discussion gray scale images are used. In Thresholding a pixel intensity value is adjusted, by taking the given value as reference the low intensity pixels will become zero and rest of the pixels will become 1. The result of the Thresholding is a binary image containing black and white pixels.

D. Feature Extraction:

Shape Features: shape-based image retrieval consists of measuring the similarity between shapes represented by their features. Some simple geometric features can be used to describe shapes [1]. Usually, the simple geometric features can only discriminate shapes with large differences; therefore, they are usually used as filters to eliminate false hits or combined with other shape descriptors to discriminate shapes.

They are not suitable to be stand- alone shape descriptors. A shape can be described by different aspects. These shape parameters are Center of gravity, Axis of least inertia, Digital bending energy, Eccentricity, Circularity ratio, Elliptic variance, Rectangularity, Convexity, Solidity, Euler number, Profiles, Hole area ratio, Area, Length, Perimeter.

E. Classification:

The classification process is done over the segmented images. The main novelty here is the adoption of Random Forest. RF classifier is applied over the segmented images and the classification is done.

<u>Random Forest:</u> Random forests or random decision forests are an method for learning classification, regression and other tasks, that operate by constructing a multitude of decision trees at training time and outputting the class that is the mode of the classes (classification) or mean prediction (regression) of the individual trees. Random decision forests correct for decision trees' habit of over fitting to their training set.

One of the foremost common ways or frameworks utilized by knowledge scientists at the ‘rose knowledge science skilled follow cluster’ is Random Forests. The Random Forests formula is one in every of the simplest among classification algorithms -able to classify giant amounts of information with accuracy. Random Forests are associate degree ensemble learning technique (also thought of as a kind of nearest neighbor predictor) for classification associate degreed regression that construct variety of call trees at coaching time and outputting the category that's the mode of the categories output by individual trees (Random Forests may be a trademark of Leo Bremen and Adele monger for an ensemble of call trees).

3. CONCLUSIONS

A novel red lesion detection method based on a new set of shape features, the DSFs, was presented and evaluated. 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.

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