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A Survey on Detection and Classification of Diabetic Retinopathy Techniques

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Abstract: Now a day's Diabetic Retinopathy (DR) is a important disease in the diabetic people. DR is a disease which progressively damage blood vessels in the retina. People with diabetes mellitus need annual check-up to know the development of diabetic retinopathy (DR). If it is not treated in early stage, it may result in vision loss or in some cases blindness also. It will cause a serious disease called glaucoma. To avoid this causes regular eye examination is necessary to detect DR timely and can start treatment of DR at an early stage. The early symptoms of DR which appear on the surface of the retina are the dark lesions such as haemorrhages, exudates and micro aneurysms. The shape and size of these lesions are helpful to indicate the severity level of diabetic retinopathy. A computer-aided diagnosis system can help to reduce all these complications. So, in this paper, a survey of detection and classification of red lesions techniques and automated systems are discussed.

Keywords: Neovascularization Detection, Diabetic Retinopathy (DR), Fundus retinal image, vessel morphological features, Automatic Detection, Microaneurysm, SVM.

I. INTRODUCTION

People which has diabetes can have an eye disease called Diabetic Retinopathy. Due to high blood sugar levels damage the blood vessels in the retina. These blood vessels are swell, and blood is leaked from vessels or they can close, stopping blood passing or sometimes abnormal new blood vessels grow on the retina. [1] Due to all these complications or change in the retina lead to vision loss. Diabetic retinopathy is a complication of diabetes that damages blood vessels in the retina of the eye. Macular degeneration and glaucoma are most important causes of blindness in the developed world [2]. Regular eye check-up will reduce the risk of vision loss and blindness [3]. Laser treatment is used for treatment of diabetic retinopathy. All people with diabetes is at risk of developing diabetic retinopathy. DR is also caused by the micro vascular complication of diabetes and it is one of the main sources of vision impairment. Diabetic retinopathy (DR) and age-related macular degeneration (AMD) are nowadays two of the most frequent causes of blindness and vision loss. If disease is found at an early stage, then can be detected early and prevented from blindness. People are become blind due to of DR is increasing day by day. Fundus camera gives digital retinal images which are used to diagnose DR. There are two types of DR i.e. Non-proliferative diabetic retinopathy and Proliferative diabetic retinopathy (PDR).

A. Non-Proliferative Diabetic Retinopathy (NPDR)

It is the earliest stage of diabetic eye disease. Minute changes occur in the blood vessels of the eye in non-proliferative disease. This changes typically do not produce symptoms and are not visible to eye.

B. Proliferative Diabetic Retinopathy (PDR)

Proliferative retinopathy is an advanced form of the disease. It occurs when too many new blood vessels are generating, and this new vessel are very fragile and thin so it can easily break, or damage and blood will leak from retina. So, it results into a sudden loss of vision. DR is defined by the presence of neovascularization termed as abnormal formation of blood vessels in the retina, which causes a serious problem. So, an immediate referral to an ophthalmologist for treatment is required for patients diagnosed with the presence of NV. So consistent and appropriate identification of NV is essential as it can cause a high risk for sudden vision loss.

The current eye care practice for DR involves examination of multiple field fundus images for finding abnormalities by a trained expert. Depend on the observed abnormality in the retina at the time of the examination, diabetic patients are referred to an ophthalmologist for further diagnostic evaluation and possibly treatment. This procedure is time consuming and requires many diabetic eye care resources. So, there is a need to develop an automatic computer-aided diagnose system for detection of Diabetic Retinopathy to identify between normal and abnormal blood vessels present in the digital retinal image.

II. LITERATURE SURVEY

A. Multi-Level Gabor Filtering Based Method

Shuang Yu [1] proposed method for automatic Neovascularization detection using multi-level Gabor filtering. NV is indicator of Proliferative Diabetic Retinopathy. Figure 1. shows the architecture of the neovascularization detection.

- 1) *Optic Disc Detection:* Local phase symmetry algorithm is used to detection of the optic disc [4]. It is performed on the green channel with blood vessels are removed. It is useful to find out the centre of the optic disc. After getting centre of optic disc, then to locate boundary of optic disc region growing algorithm used.
- 2) *Pre-Processing:* Illumination inside of the optic disc and outside of the optic disc is totally different, it will lead to complication for extract the blood vessels. So, illumination correction algorithm is used to remove uneven brightness. Non-local means filter is used to get major vessels and remove fine vessels. Non-local means filtering calculate the mean of all pixels in the image and find similarity of pixels with target pixels [5].
- 3) *Vessel Segmentation:* Neovascularization contains presence of abnormal thin vessels, so vessel segmentation is required for NVD detection. To extract the blood vessels multi- scale Gabor filtering is used [6]. It finds out vessels of different widths and dimensions. It can extract both thin and thick vessels. The new vessel candidate image obtained by subtracting thick vessels image from full vessel image.
- 4) *Feature Extraction:* Feature extraction step important for image classification. Two types of features are extracted such as vessel morphological features and texture features. vessel morphological features are vessel width, pixel length, tortuosity and weighted length, weighted tortuosity parameters. Texture features are Fractal dimension and Granulometry.
- 5) *Feature Selection:* Due to limited database size, dimension reduction is important for giving training to machine learning models. Recursive feature elimination algorithm is used to find out important feature.
- 6) *Support Vector Machine:* Support vector machine is used to classify NVD images and non-NVD images. SVM is supervised learning algorithm which find out decision boundary with maximum margin for training dataset [7].

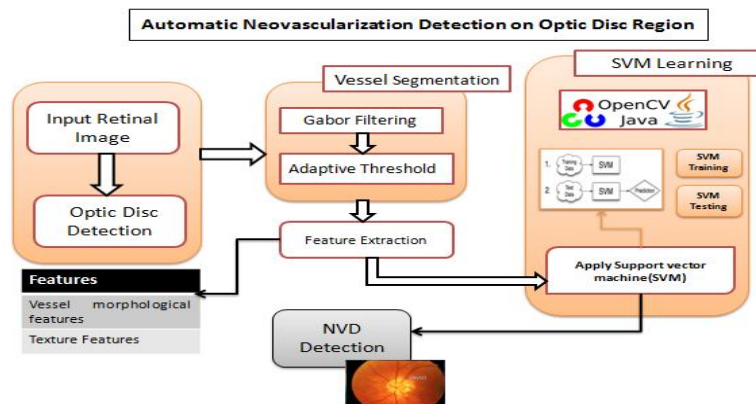


Fig 1: System Architecture

B. Laplace of Gaussian Operator Method:

Kedar M. Adal [8] proposed a automated method for detection of retinal changes in fundus images using LOG operator.

- 1) *Illumination Normalization and Registration:* For fundus image analysis green channel is mostly used because it has more contrast between retina features than the background of blue and red channels. Green channel images show large contrast between retina structures [9]. In presented method, robust fundus image registration method is used for normalized intensity. The method applies on four field that are macula-centered, optic nerve-centered, superior and temporal.
- 2) *Retinal Change Detection:* In DR, small blood vessels are swelled or damage. Due to this blood are leaked from the retina and blood clot is formed. It looks like round and small red spots in colour retinal fundus images. To detect this roundish red spots Laplacian of Gaussian operator is proposed. It is highlight red spots. Blobness measure is proposed to find out difference between blobness response at two time points.
- 3) *Feature Extraction:* Two types of features are extracted for classification purpose that are Intensity features and Appearance and Shape Descriptors.
- 4) *Red Lesions Classification:* For red lesions classification K-nearest neighbour (KNN), random forests (RF), Support Vector Machine (SVM) are used.

C. Local Convergence Index Features based Method

Behdad D. proposed [10] Local Convergence Index Features for automatic detection of Retinal Microaneurysms. Retinal Microaneurysms is very early sign of DR disease. Detection of Microaneurysms is very critical because DR in early stage.

- 1) *Pre-processing*: From RGB channels only Green channel is used because it provides better contrast for Microaneurysms (MAs) and background. Image pre-processing is done by method which adjust both luminosity and contrast.
- 2) *Gradient Weighting*: For each pixel multi-scale multi-orientation weights are calculated on each pixel.
- 3) *MAs Candidate Extraction*: This is important phase in automated detection of Microaneurysms. Suitable candidate selection algorithm is proposed to decrease false positive rate and complexity. Iterative Thresholding used for obtained set of binary images.
- 4) *Feature Extraction*: Feature extraction is very important for final classification stage. So Microaneurysms images appear in different colours and sizes, shapes, intensities. Different types of features are extracted such as Intensity-based features which indicate darkness compared to their near background. Intensity features are extracted at centre of the candidate. Intensity-based features such as area, convex area, solidity, extent, perimeter, circularity, ellipticity, eccentricity, Euler number etc. LCF-based feature also extracts.
- 5) *Supervised Classification*: To differentiate Microaneurysms from non- Microaneurysms use hybrid sampling/ boosting algorithm. It is called RUSBoost which combine with a random under sampling technique [11].

III. APPLICATIONS

This section gives the application for the given systems. Automatic Neovascularization detection is important for preventing vision loss due to DR. And Diabetic retinopathy (DR) is a progressive eye disease cause due to increase of insulin in blood and can cause blindness if not detected timely.

- A. This system can be used to detect abnormal blood vessels and grading of proliferative diabetic retinopathy.
- B. Neovascularization detection can be done effectively with high sensitivity and specificity for both the training set and test set.
- C. The system can help ophthalmologist to take decision in the diabetic retinopathy screening In process.

IV. EXPERIMENTAL ANALYSIS

Table.1. Comparison Results of Methods for Diabetic Retinopathy Detection:

Author	Methods	Datasets	Performance Measure
Shuang Yu	Multi-level Gabor filter	Kaggle datasets	Accuracy-95.23%, Specificity-96.30%, Sensitivity-92.90%
Kedir M. Adal	LoG Operator	A regular DR screening program at the Rotterdam Eye Hospital.	Sensitivity-80%
Behdad D.	Local Convergence Index Features	e-optha-MA dataset, RC-RGB-MA dataset, MESSIDOR, ROC, RC-SLO-MA dataset, DiaretDBI.	Sensitivity-0.471 on ROC dataset.

V. CONCLUSION

This review presents a detailed survey of different techniques and results used for the automatic detection of Diabetic Retinopathy. The process of analysing retinal changes involves number of stages such as Image acquisition or registration, Image pre-processing, extraction of features and Classification. All these phases include various techniques or algorithms.

In this paper, we surveyed a novel automated solution for NVD detection procedure with vessel segmentation using multi-level Gabor filtering, feature extraction of vessel morphological features and texture features. By using support vector machine image classification is to be done. LoG operator is used to find out red lesions in fundus images. It focusses on dark red spots which is blood clot due to damage of blood vessels. Local Convergence Index Features is used for automatic detection of Retinal Microaneurysms to early detection of diabetic retinopathy.



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