Review of Methods of Retinal Image Processing for Diabetic Retinopathy with Research Datasets

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Abstract: *From the recent studies, the automatic extraction of features and lesions from the input retinal image can resulted into the early detection of disease and hence the screening of disease called as Diabetic Retinopathy (DR). The DR is consisting of lesions characteristic group extracted from the retinal image of individual person had diabetes for several years. In this paper we are aiming to present the different techniques for automatic localization of different retinal features as well as lesions. As this is first review paper, during this paper we are discussing the process of automated retinal disease recognition in DR in terms of different steps involved. Further this paper address different research retinal images datasets those are widely used by researchers for evaluation of their different techniques. The survey is presented on various methods used for the identification of macular edema as well. The detection of macular edema assists ophthalmologists in order to apply proper treatments which resulted into the elimination of disease completely or minimize its severity. 2mg. (10)*

Key Word*: Diabetic Retinopathy, Retinal Image, Features Extraction, Blood Vessels, Exudates, Optic Disc, Macular Edema, World Health Organization*

I. Introduction

Recently the World Health Organization (WHO) overall in world, there are about 135 million people have diabetes mellitus. And this number may increase up to 300 million by 2025. The analysis of medical image is growing research area which attracts number of researcher's interests for new methods and algorithms for different purpose. This approach is composed of digital images study with aim of providing computational tools. These tools further assist the quantification as well as visualization of anatomical structures and interesting pathology. Progress in this area has been achieved in recent years; medical care is available for that type of patients improved significantly.

Diabetes care for serious progress is current health of the biggest immediate challenges. The number of people affected a startling wall List rate continues to grow. According to a recent survey, 4% of the country's population have been diagnosed diabetic disease alone and it has been recognized and is a main cause of blindness in the country as accepted if not properly treated and. early detection and diagnosis to obtain a reduction in the percentage of visual way as Have been identified with emphasis on medical routine due to diabetes with loss that examine the use special features to detect and monitor the said disease.

A lot of approaches have been suggested and identified as means of reducing the stress caused by this constant check up and screening related activities among which is the use medical digital image processing for diagnosis of diabetes related disease like diabetic retinopathy using images of the retina. Diabetic retinopathy can be broadly classified as non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR). Therefore, regular screening of diabetic patient's retina is very important. And, automated or computer assisted analysis of diabetic patients retina can help eye care specialist to screen larger populations of patients. Since from last decade, there are many research work presented by different authors over the automatic detection of diabetic retinopathy by making use of different kinds of features as well as methods. Below we are discussing some of these recently presented methods.

In [3], author have analyzed the performance of three different template matching algorithms in respect of the detection of blood vessels in the retinal images for both gray level and color images. Blood vessels detection using the proposed 2D Gaussian matched filtering gives the complete and continuous vessel map of the blood vessels.

[4], the author is a computational model, the retinal vasculature and proposed to remove from the eye funds images and then retinal vessels bifurcations and crossover points to locate their facilities. [5], the author to remove vascular network, using akariki operators proposed. [6], the authors proposed that fluoresceinlabeled retinal blood vessels o f 27 were automatically segmented digital images using Gabor Wavelet transform and traditional features such as Categorized using the area, perimeter and an additional five morphological features based on the derivatives of the Gaussian Wavelet obtained data.

In [7], author proposed that, the matched filter response to the detection of blood vessels is increased by proposing better filter parameters.

In [8], author proposed a method to distinguish mild NPDR from severe NPDR using a procedure that involves Global image feature extraction. The vascular abnormalities are detected using scale and orientation selective Gabor filter banks.

In [9], author have used back propagation algorithm for classification of the four stages of eye images of Diabetic Retinopathy. The contents is extracted from the raw images using the image processing techniques and fed to the feed forward neural network classifier for classification.

In this paper we are presenting the review of DR methods and techniques. In addition to this we are presenting the information related to different types of retinal image datasets as well. In section II below we are first discussing the basics of DR, in III different methods used for the detection of diabetic disease. In section IV we are presenting the different retinal research datasets.

II. Basics of Diabetic Retinopathy

The vision to the human beings is supported by Eye. Eye is housed in socket of bone which is called orbit and is protected from the external air by the eyelids. Following figure 1 is showing the cross section of eye and in next figure 2 is showing the retina section of figure 1.
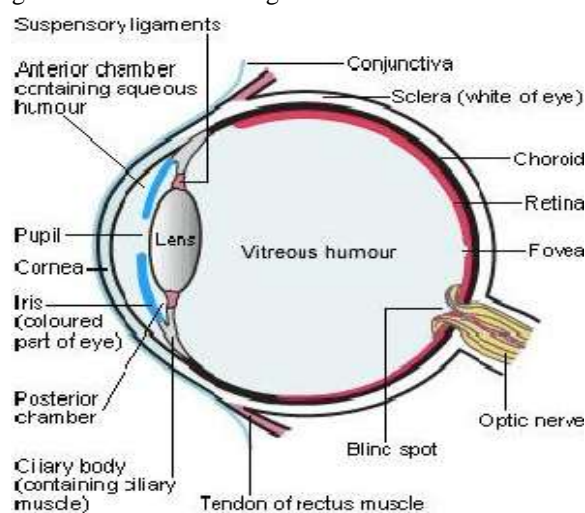
Figure 1: Human Eye Structure

Light enters the eye through the pupil and is focused on the retina. The lens assists in focusing images from different distance. The amount of light entering the eye by IRIS, light bright and Dim the lights when opens when is controlled by closing out a transparent eye. White sheet kanjaktiva culinary body called culinary muscle controls automatically focuses the lens of the eye structures for nutrition Choroids. Supply vascular layer of the retina on the image of form in to the brain by the optic nerve spreads. Optic disc retinal image is brighter than any part of and normally rounded in shape it is also entry and exist to enter and leave the retina and brain from nerves to a point near the center of the retina oval shape object malik. Malik is near the center of the Fovea and pack it light sensitive cone cells. Cells, due to the high volume of fovea are responsible for the most perfect vision. The retina of the eye sensory tissue that lines a multilayered is behind millions of photoreceptors that capture light rays and convert electrical impulses to travel with these impulses from the optic nerve to the brain where they are turned into images of photoreceptors in the retina. There are two types: rods and cones is approximately 6 million cones retina.
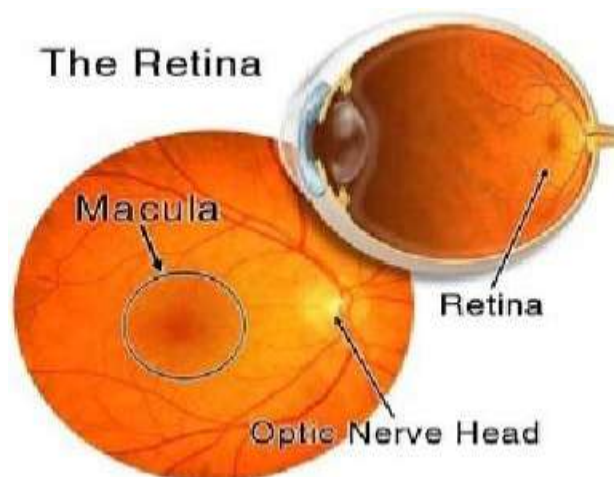
Figure 2: Original Retinal Image

Cone is responsible for central vision portion of the retina malik are contained in the most densely fovea, malik's very center part are packed within. Cones and bright colors is the best light Festival to appreciate us.

Diabetic Retinopathy: Diabetic retinopathy, light sensitive inner layer of the eye retina caused by damage to blood vessels. There are two types: non proliferative and proliferative. No proliferative diabetic retinopathy is the early stages of the disease and fewer blood vessels in the eye retina. which leads to blurred vision to fluid leaks. Proliferative retinopathy disease, more serious and more advanced is the new blood vessels in the eye. These new vessels are fragile and can start bleeding (hemorrhage), which may cause vision loss and scarring of the retina. more serious for a long period of time diabetic retinopathy if diabetes is poorly controlled and is likely to be more severe retinopathy also likely increases before and found virtually everyone who has diabetes is more than 30 years to show symptoms of diabetic retinopathy Symptoms of diabetic retinopathy will blindness, Blurred vision, Floaters and shadow or missing areas of vision. Eye of major bleeding before many people is in early diabetic retinopathy with no symptoms. So everyone with diabetes should have regular eye exams.

III. Review of Different Disease Identification Methods

Multimodal registration of Paul et al (2002) is used to detect glaucoma. Performance comparison of different techniques is analyzed in detail Conor et al. (2002) abnormal images. To detect changes is in retinal Anatomy for determining skeletal operations. Features in this work used the vessel width and tortuosity. In the case of use accuracy analysis Agostino et al. (2003) to detect abnormal retinal images keratoconous neural network method is used, based on the sensitivity and specificity experimental analysis. This work is performed in an extensive quantitative analysis yielded the report. Alireza et al. (2003) used United FCM and neural technologies to detect diabetes retinal exudates images. The convergence rate reported in this work is also significantly high Koen et al. (2005) to detect glaucoma retinal images change developed a model to determine sensitivity and specificity in terms of the outcome. Analysis harihar et al (2005) abnormal retinal image classification is using Bayesian algorithm. Multi-level classification performed in this work with five classes. Markov random field used in the automated system concept is superior quality classification accuracy in the Method are reported. a comparative analysis on various automated drusen detection techniques are informed by Buchanan et al. (2006Contrast normalization method based micro aneurysm detection in retinal images Allen et al. (2006). the detection detected based on the width of blood vessels. experimental results in terms of sensitivity and specificity analysis. but in this method in the case of small size abnormalities fails multi fractal analysis of human retinal images Tatijana et al (2006).

This approach is mainly used to detect the blood vessels which further aid in differentiating the different abnormal images. Texture based techniques and model based techniques are analyzed in detail in this report. Lack of quantitative analysis is the major drawback of this automated system. An automated system for glaucoma detection in retinal images is proposed by Kolar et al. (2006). The fused images are used as input for this system. Fusion is performed through multimodal registration method. The analytical approach to distinguish normal and unusual images used Xin et al. (2006) retinal images to explore morphological operation wound used. Thomas et al. Micro aneurysms color funds images (2007) to find out the kernel density estimation method using is automatic thres holding techniques. Also used to produce accurate results is in post processing. Lack of strength of this approach is the major drawback. Fuzzy theory and neural network hybrid approaches Jayakumari et al. (2007) is used hard exudates is unusual. Using this approach is

proposed method showed images of this approach is the major drawback is a very low number of images has been tested on.

Supervised algorithm for differentiating different retinal diseases is designed by Meindert et al. (2007). The work is depending on the pixel classification technique. This method is tested on a huge dataset which shows the robust nature of this approach. Morphology based disease detection is performed by Raghu et al. (2007). Operators such as slicing, Erosion is used in the automated system. Lack of quantitative analysis of this approach is the major drawback. Acharya et al. (2007) abnormal retinal image to identify the disease in RBF classifier used k-means algorithm is features by using fuzzy and then derive classifier to the automated system supplied on unusual images which this system can prove generalizing capability Ncha tested different kinds. Povilas et al. (2007) used for multi-layer perception ophthalmologic disease classification. Initially, principal component analysis features are extracted and then used to feature, but the success rate of this method is based on the input feature set. Wavelet based micro aneurysms detection in retinal images is performed by Gwenole et al. (2008). This system also involves the concept of template matching. Images from different modalities are used in this work and a comparative analysis reveals the superior nature of the proposed approach.

Linear Discriminate Analysis based abnormal retinal image classification is performed by Clara et al. (2008). Applicability of the different varieties of unusual images this approach is used to examine the used database, but to ensure the strength of the proposed technique is not big enough. Morphological operation based Dr. Detection Jake et al. (2008) is implemented by using morphological operators remove features then neural classifier is used as input for. Reported in this paper only confirmed taxonomy Wong et al. (2008) diabetic retinopathy (Dr) at different stages of differentiation of retinal images Back Propagation Neural Network (BPN) is used as the classifier in this work. A specificity of 100% is reported in this work. Cemal et al. (2008) the inverse method of retinal images split macular degeneration is used to locate the various properties of retinal images. This work is used and the proposed system in the whole data set yielded better results. Mathematical methods for akariki Dr. Exudates detection Akara et al. (2008) used by different morphological operations. are used in this work and exudates detection for these operations is analyzed in detail, but the effects of the blood vessels of the precise figure proposed system is necessary to ensure high success rate. Rajendra et al. (2008) has used the higher order spectral features for DR identification in retinal images. The fuzzy clustering approach has been used for exudates detection in DR images by Akara et al. (2009Fuzzy C-means (FCM) algorithm in this work to explore unusual area is used for many performance measures quantitative analysis is an added benefit of this work is done in this work. information fusion to determine the retinal images Meindert Dr et al. (2009). through various different fusion methods experiments are analyzed in this work. quantitative results are estimated in this work a comparative analysis of optical disk; through indirect Dr. identity Arturo et al. (2009) is implemented by Hough transform filtering techniques, analytical concepts. as this system Dr. retinal images are used to detect system a large Dataset which is an added benefit of this technique has been tested on.

The application of multi-layer perception for hard exudates detection in retinal images is explored by Maria et al. (2009). Radial basis function (RBF) neural networks and support vector machines (SVM), a comparative analysis is also provided in this report. Winder et al. (2009) the different partition technique to determine the retinal images than Dr. different data set compared to the performance of the techniques reported. The report also clearly merits and demerits of various techniques available in the literature. Level method based lesion detection Elizabeth et al. (2009) a comparative analysis with other techniques is also applied by dividing the work, the nature of the proposed algorithm has been provided to show the best neural network based auto associative retinal disease set. Identification Jubilee et al (2010) is implemented by an appropriate Extracted and processed images before the feature set for classification is supplied for neural classifier. Lack of quantitative analysis of this approach is the major drawback. Carla et al (2010) to determine the retinal images in multistage method. This work with multi level classification is in four sections. Distance metrics are used to measure the inter-structure similarity in this approach Keerthi et al. (2011) has handled the clutter based rejection technique for Diabetic Retinopathy detection in retinal images. Some inferences defined from this survey are as follows:

- Most commonly the experiments is done with publicly available databases
- The survey suggested having a large dataset to ensure the robustness of the automated systems.
- Green channel plane of the input RGB retinal image is widely used for processing.
- Less emphasis is provided on feature extraction techniques based on textural features.
- Very few works are based on soft computing techniques for anatomical structure detection.
- Combination of textural based features and anatomical structure based features are very rarely used.
- The usage of optimization strategies for feature selection is very low.
- Most of the works are based on only anatomical structure identification and no emphasis is given on disease classification techniques.

- In the very few pathology identification techniques, most of the experiments are based on bi- level classification systems which are not sufficient to prove the capability of the proposed approach.
- Artificial Intelligence techniques are rarely used for the retinal image processing applications.
- Most of the results are reported in the form of qualitative analysis only (No quantitative analysis). The drawbacks of the previous works are clearly understood from the literature survey and hence suitable techniques are to be developed to maximize the performance measures of the automated systems. Based on the literature survey, the focus of this research work will be on:
- To implement Novel pre-processing techniques (hybrid approaches) for quality enhanced outputs.
- To extract novel textural features and to implement AI based techniques for anatomical structure detection.
- Feature selection is rarely used in the field of ophthalmology. Optimization approaches including evolutionary algorithms are to be implemented in this work.
- Literature survey reveals that very less work is based on soft computing techniques. So techniques such as Artificial Neural Networks, Fuzzy theory, Hybrid approaches used in this work.

IV. Retinal Image Public Database

DRIVE (Digital Retinal Images for Vessel Extraction): The DRIVE database has been established to enable comparative studies on segmentation of blood vessels in retinal images. Test the database research community on their algorithms and results through this Web site [10] other researchers invited to share with the drive of the diabetic retinopathy screening photos database program was obtained in the Netherlands. Screening the population aged between 25-90 400 diabetic subjects. Forty photographs randomly selected Show no signs of diabetic retinopathy, 33 and 7 light show signs of early diabetic retinopathy. Each image has been JPEG compressed [10]. The images were acquired using a Canon CR5 non mydriatic 3CCD camera with a 45 degree field of view (FOV). Each image was captured using 8 bits per color plane at 768 by 584 pixels. FOV is approximately 540 pixels of each image with a diameter of the FOV cropped around the images to the database. For each image, a mask image provided that delineates FOV [10].

MESSIDOR: The MESSIDOR database has been established to facilitate studies on computer- assisted diagnoses of diabetic retinopathy. The 1200 eye funds color numerical images of the posterior pole for the MESSIDOR database were acquired by 3 ophthalmologic departments using a color video 3CCD camera on a Topcon TRC NW6 non-mydriatic radiograph with a 45 degree field of view [11]. The images were captured using 8 bits per color plane at 1440*960, 2240*1488 or 2304*1536 pixels. 800 images were acquired with pupil dilation (one drop of Tropic amide at 0.5%) and 400 without dilation [11].

Department of ophthalmologic 1200 images 3 sets are packed into one per each set of 4 zipped TIFF format and sub for each image in an Excel file with medical diagnosis each set containing 100 images is divided into[11]. Medical diagnoses: Two diagnoses have been provided by the medical experts for each image:

- - Retinopathy grade
- - Risk of macular edema

Retinopathy grade
- - 0 (Normal): $(\mu A = 0)$ AND $(H = 0)$
- - 1 : $(0 < \mu A <= 5)$ AND $(H = 0)$
- - 2 : $((5 < \mu A < 15)$ OR $(0 < H < 5))$ AND $(NV = 0)$
- - 3 : $(\mu A >= 15)$ OR $(H >=5)$ OR $(NV = 1)$

μA: number of micro aneurysms H: number of hemorrhages
NV = 1: neovascularization - NV = 0: no neovascularization
Risk of macular edema
Difficult exudates is used to mark the risk of macular edema
- - 0 (No risk): Not found any visible hard exudates
- - 1: Low difference between macula & hard exudates > one papilla diameter
- - 2: limited space between macula & hard exudates <= one papilla diameter

All of the images contained in the database were used for making actual clinical diagnoses.

STARE Dataset: Gaze (retinal structural analysis) project conceived and Michael Goldbaum, MD, University of California, San Diego in 1975 it was launched in U.S. was funded by the national institutes of health. Its history, more than thirty people with backgrounds ranging from engineering to medical science contributed to the project. Images and clinical data Shiley eye Center at the University of California, San Diego, and the Veterans Administration Medical Center in San Diego provided by [12].

V. Conclusion and Future Work

This is our first review paper; in this paper we presented the different aspects of DR detection. First we had given the introduction to the basic terms and concept of DR in details. After that we have discussed the

different retinal datasets. In this paper we have described three major retinal datasets like STARE, DRIVE and MESSIDOR. In addition to this we have presented the review of different methods those are proposed by various authors for diabetic disease detection.

Recently there are many automated techniques presented for the detection of diabetic disease with their grading of severity. The basic aim of this paper is to introduce the concepts of DR, different datasets used, and different techniques presented for detection of DR. For the future work we like to suggest working on efficient methods for features like blood vessels, exudates, optic disc extraction etc and improving the detection accuracy.

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