A Critical review of expert systems for detection and diagnosis of Diabetic retinopathy

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Abstract—Diabetes, which can be characterized as a chronic increase of glucose in the blood, has become one of the most rapidly increasing health threats worldwide. Diabetic Retinopathy (DR) means "Retinal changes occurring in diabetes mellitus, marked by microaneurysms, exudates, and hemorrhages, sometimes by neovascularization".
DR is considered as a root cause of vision loss for diabetic patients. Due to this health threat, lots of research work has been carried out on images using computer science to assists medical professionals. Ten papers which use different techniques for diagnosis and detection of Diabetic Retinopathy are reviewed. One best paper is "Automatic Extraction of Optic Disc(OD) and Exudates from Retinal Images using Marker-controlled Watershed Transformation" as it gives average sensitivity 95% with the proposed method. Various methods such as high gray level variation, area threshold, Hough transform, back tracking technique, morphological filtering techniques, watershed transformation, principal component analysis and point distribution model have been reported for the detection and extraction of Optic Disk. Various methods such as shade correction, contrast enhancement, sharpening, combination of local and global thresholding, color normalization, fuzzy C-means clustering and neural networks has been reported for the detection and classification of exudates.
Keywords – DR, OD

I. INTRODUCTION

The eye allows us to see and interpret the shapes, colors and dimensions of objects in the world by processing the light they reflect or emit. Eye is an organ associated with vision. It is housed in socket of bone called orbit and is protected from the external air by the eyelids. Light enters the eye through the pupil and is focused on the retina. Image formed on the retina is transmitted to brain by optic nerve. Following figure shows the normal retina of human eye.

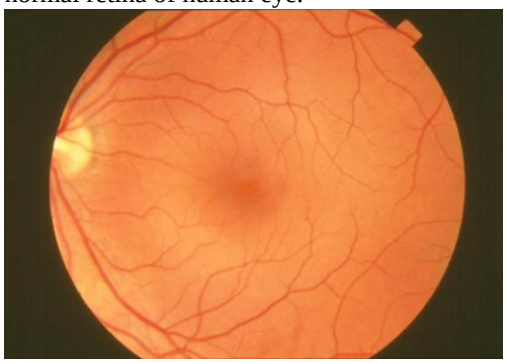

Figure 1. Image of Normal human retina [1]

Whenever Retinal changes like microaneurysms, soft and hard exudates, hemorrhages, neovascularization are available on the retina then that is called as a diabetic retinopathy. Following diagram shows human eye retina with these symptoms.

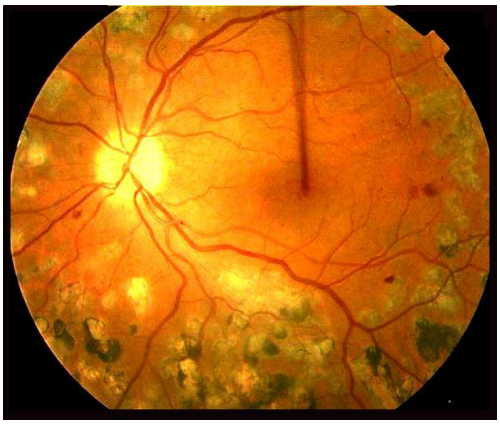

Figure2 Image Of Human Retina with Diabetic Retinopathy[2]

Several techniques are invented to find abnormalities related to retina. Some techniques are discussed here by reviewing papers.

Ahmed Wasit Reza and et.el. has detected Exudates from retinal image database using marker-controlled watershed transformation. This paper presents an automatic tracing technique for the boundary detection of bright objects, such as optic disc, exudates and cotton wool spots. The proposed method makes use of Average filtering, contrast stretching Transformation, Gradient magnitude, Extended minima transformation, Euclidean distance transform, Minima imposition and Watershed transform.
It mainly uses-

- Preprocessing algorithms to make the bright object features more distinguishable from the background.
- Markers to modify the gradient image to control over segmentation.
- Watershed segmentation to trace the boundary from the marker modified gradient.

The method has been tested on images of publicly available databases DRIVE and STARE. The software tools selected are from the MATLAB image processing toolbox. They have got average sensitivity 95%. As per their view this work may be extended to distinguish between normal and pathological retinas with this method[3]

S.Kavitha and et.al. has detected hard and soft exudates in fundus image using color histogram thresholding. A series of experiments on classification of hard and soft exudates is performed with the use of image processing techniques. Initially the color fundus retinal images are taken for preprocessing for CIELab color space conversion using binarization and Fundus region mathematical morphology. The optic disc is detected and localized with the aid of region props and color histogram. Exudates are detected with the aid of thresholding color histogram, which is used to classify the hard and soft exudates pixel from the color fundus retinal image. Method is applied on publicly available dataset DIARETDB1. They have got 89.78% sensitivity, 99.12% specificity and 99.07 accuracy [4].

V. Vijaykumari and et.al. has developed a method for exudates detection in retinal image using image processing techniques. Finding the main components in the fundus images helps in characterizing detected lesions and in identifying false positives. Here few methods [Feature Extraction, Template Matching, Minimum Distance Discriminant Classifier, Enhanced MDD classifier] are used for the detection. Optic Disc is traced out and removed from the retinal image and the performance of all is compared.[5]

Arturo Aquino and et.al. has detected optic disk in retinal image of diabetic patient with retinopathy and risk of macular edema. The detection process has two methodologies. Location methodology obtains a pixel that belongs to the OD using image contrast analysis and Structure Filtering technique. A boundary segmentation methodology estimates a circular approximation of the OD boundary by applying mathematical morphology, edge detection technique and the circular Hough Transform. These methodologies were tested on a set of 1200 images. The location methodology obtained 98.83% success rate and the OD boundary approximation 94.58%. This work may be useful for developing system for detection of glaucoma, macular edema and other ophthalmic diseases. This work was supported and funded by the Health Ministry of the Andalusian Regional Government (Spain) [6].

Rangaraj M. and et.al has detected optic nerve head in fundus image of the retina with Gabor filters and phase portrait analysis. They have proposed a method using Gabor filters and phase portraits which locate the optic nerve head (ONH) in fundus images of the retina. The method includes detection of the vessels using Gabor filters, detection of peaks in the node map obtained via phase portrait analysis, and an intensity-based condition. The method was tested on 40 images from the Digital Retinal Images for Vessel Extraction (DRIVE) database and 81 images from the Structured Analysis of the Retina (STARE) database. The evaluation of the results includes free-response receiver operating characteristics (FROC) and a measure of distance between the manually marked and detected centers. With the DRIVE database, the centers of the ONH were detected with an average distance of 0.36 mm (18 pixels) to the corresponding centers marked by the ophthalmologist. FROC analysis indicated a sensitivity of 100% at 2.7 false positives per image. With the STARE database, FROC analysis indicated a sensitivity of 88.9% at 4.6 false positives per image. They have used free databases and for testing and analysis have indicated 88.9% sensitivity at 4.6 false positive per image. This work was supported by the Natural Sciences and Engineering Research Council of Canada. [7]

Neera singh and et.al. used image analysis techniques for detection of Diabetic Retinopathy. The automated Diabetic Retinopathy diagnosis system is thus used to detect various lesions of the retina and there count size and location to assess the severity of the disease. For this normal eye features and DR eye have to be differentiated for e.g. optic disc has the same pixel brightness as the exudates and thus has to be localized before detecting exudates. Similarly the blood vessel and fovea region have to be subtracted from the retinal image before diagnosing microaneurysms and hemorrhages. For these different methods like grey mathematical morphology, top-hat transform, fuzzy clustering etc are used for early detection of diabetic retinopathy.[8]

P.N. Jebrani sargunar and et.al. detected and classified exudates in diabetic retinopathy images by texture segmentation methods. They proposed a tool for the early detection using fuzzy c-means clustering, fractal techniques and morphological transformations. here an accuracy of 85% is achieved.[9].

Ahmed Wasif Reza and et.al. proposed a new algorithm based on RGB color channels for the automatic detection of blood vessels in fundus images. DRIVE database images are used as an input and the results are compared with those obtained by other known methods. It is found that the new technique achieves better sensitivity values and less effect of noise compared to other methods. This research work is supported by E-Science Project (No: 01-02-01-SF0025) sponsored by Ministry of Science, Technology and Innovation (MOSTI), Malaysia. [10]

Jagadish Nayak and et.al have proposed an approach using digital fundus image for diagnosis of DR. Image processing, morphological processing technique and texture analysis methods are applied on fundus image. From the database normal, NPDR, PDR types of images are identified. This system gives accuracy of 93%, sensitivity of 90% and specificity of 100%. This project was supported by Tote Fund, Singapore [11]

Katia Estabridis and et.al. developed a system which detects the fovea, blood vessel network, optic disc, and bright, dark lesions associated with DR. detection of normal part is one initially an lesion detection is accomplished through the process of eliminating the normal component. Two databases were used to design and test the work. One database contains high resolution images and other contains low resolution.[12]

II. CONCLUSION

Different techniques are used in these papers are for detections and diagnosis of Diabetic retinopathy symptoms like microaneurysms, exudates, and hemorrhages and locating Optic Disc. It is found that in the research work carried out by Ahmed Wasit Reza and et.el. have detected Exudates from retinal image database using marker-controlled watershed transformation. They have got average sensitivity 95%. As per their view this work may be extended to distinguish between normal and pathological retinas..

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