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A Survey on Detection of Diabetic Retinopathy and Glaucoma from Fundus Images

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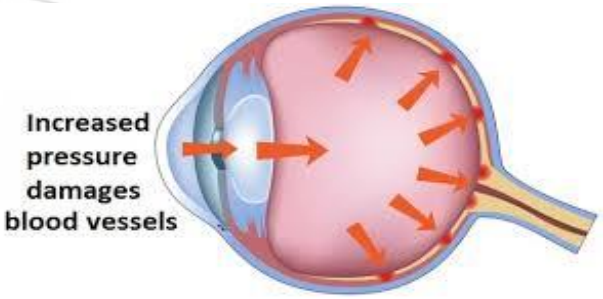
Abstract: ***Medical imaging is the process of visual representations of the interior of a body for clinical analysis and medical intervention. Detection of diabetic retinopathy and glaucoma from fundus image reduce the need of more ophthalmologists.This work involves the review of several detection and classification techniques. These mechanisms are compared and the results are examined using the parameters such as True Negative Rate(TNR), False Positive Rate(FPA), False Negative Rate(FNR) and True Positive Rate(TPR),Peak signal to Noise Ratio (PSNR),Mean Square Error Rate***

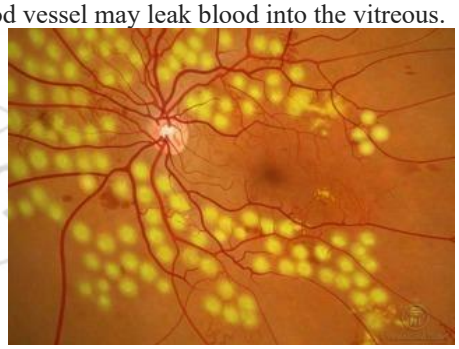
Keywords: Fundus image, Contrast limited histogram equalization, TNR, FPA, FNR,TPR PSNR, MSER.

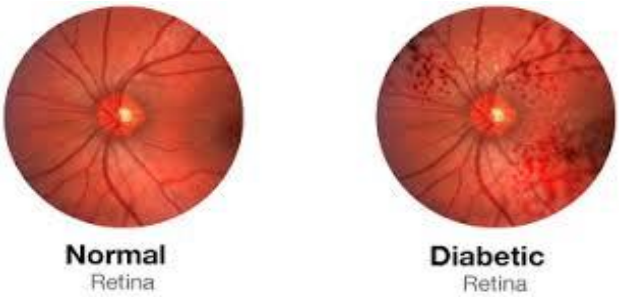
1. Introduction

Image processing is a process of processing images for which the input is an image, a series of images, or a video and also the output is either an image or a set of characteristics or parameters related to the image using mathematical operations. It allows wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing.In particular, digital image processing is the only practical technology for Classification, FeaturePattern recognition,Projection,Multi-scale signal analysis. In computer science digital image processingfocus with manipulation of digital images through a digital computer.Digital cameras generally include specialized digital image processing hardware – either dedicated chips or added circuitry on other chips – to convert the raw data from theirimage sensor into a color-corrected image in a standard image file format.Images from digital cameras can be further processed to improve their quality or to create desired special effects. This additional processing is typically executed by special software programs that can manipulate the images in a variety of ways.Diabetic retinopathy is a diabetescomplication that affects eyes. It's caused by damage to the blood vessels of the light-sensitive tissue at the back of the eye (retina).



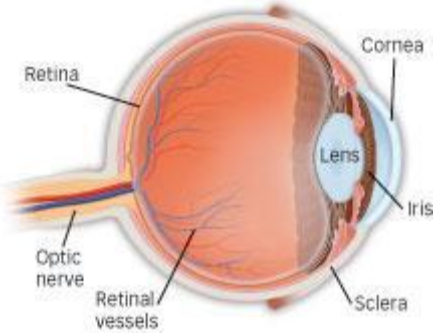
There are two types of retinopathy PDR and NPDR. Proliferative diabetic retinopathy (PDR) is the more advanced form of the disease. At this stage, new fragile blood vessels can begin to grow in the retina and into the vitreous, the gel-like fluid that fills the back of the eye. The new blood vessel may leak blood into the vitreous.





A common eye condition in which the fluid pressure inside the eye rises to a level higher than healthy for that eye. If untreated, it may damage the optic nerve, causing the loss of vision or even blindness. It is called glaucoma **affect.**

Background or nonproliferative diabetic retinopathy (NPDR) is the earliest stage of diabetic retinopathy in this condition, damaged blood vessels in the retina begin to leak extra fluid and small amounts of blood into the eye.



In this survey paper, detection of diabetic retinopathy and glaucoma techniques are discussed. The rest of the paper is organized as follows: Section 2 presents literature overview, Section 3 presents anlaysis of the techniques and algorithms, and Section 4 presents a conclusion.

2. Literature Survey

2.1 Muhammad Salman Haleem et al [1]Using SLO for retinal disease identification has advantage of its wide field of view. Because of FOV wide field of view of SLO images structure of eyelids and eyelashes are imaged. Super pixels are used to represent different irregular regions in a compact way and reduce the computing cost. ANNClassifier is used to remove these structures from retinal area. Removing structures results in montaging which provides a complete false positive rate, true positive rate which is a parameter for performance measurement. The results shows that excludes artifact from retinal area to detect diseases in retinal area

2.2 KarthikeyanGanesan et al [2] the trace transform are used to model a human visual systems which replicates as human views on images.Radon transforms are used for micro aneurysm detection. It is precursor to trace transforms- application specific functional of trace transforms are used for extracting suitable features DR fundus images. SVM kernels and PNN are used to classify the features extracted using trace transform functional. Accuracy and number of features are used for performance measurement in In house and open database. All processing was done using mat lab.

2.3 SwamidossIssac Niwas et al [3] The cross examination on the selected features allows a detailed analysis to compare the results in terms of their accuracy and F-measureOptical coherence tomography (OCT).Anterior chamber angle (ACA) and anterior segment OCT (AS-OCT) imaging techniques are used. Adaboost classifier is used in classifying ACG mechanisms. Accuracy, F-measure, sensitivity, specificity between top ranked features in MRMR and L-score are the parameters used for performance measurement. L-score method and MRMR algorithm are used which provides importance of feature selection by constructing graph using sample data points and algorithm aims to find features that are more relevant to the target classifications. It results that L-score has the capability to provide improved accuracy and F-measure with a larger feature set which consist of redundant features. Also on other hand the supervised MRMR feature selection algorithm can be useful in conjuction with the adaboost machine learning classifier in the detection of ACG mechanisms with reasonable accuracy.

2.4 A.Rajan[4] Detect proliferate diabetic retinopathy (PDR) in the way of removing blood vessels and optic disc from fundus image.Adaptive histogram equalization improves local contrast of an image and tendency to over amplify noise in homogeneous region of an image. CLACHE prevent this by limiting amplification. Blood vessels are removed by morphological dilation and optic disc are removed by circular fitting method. This results in better for segmentationof exudates which differentiates diseased persons from normal person.

2.5 M. Ponnibala et al [5]A new method for extracting blood vessels from color fundus image based on feature classification Itreduce time forexamining retinal images.Preprocessing method and in segmentation technique, matched filter and modified local entropy thresholding operation are performed. CLAHE technique which operates on small data regions. True positive, False positive, False negative, True negative are used as parameters for performance measurement.ELM is better than SVM because it provides a specificity, sensitivity accuracy more than SVM.ELM provides easy computation and successful screening method for diagnosing PDR.

2.6 Raju sahebraomaher[6] Focus a study of different stages of DR. It classifies different stages of DR achieved by three-layer feedforward neural network.BPA-Back propagation algorithm minimizes mean square error between actual output and desired output of a pre-selected neural network. This work uses configuration of neural network classifier. Grades can be used to measure performance of DR level i) normal ii) moderate iii) severeIV) proliferative. It can be enhanced by increasing number of data sets for each class and extracting better features.

2.7 JayakumarLachure[7] Detect micro aneurysms and exudates for automatic screening of DR. SVM and KNN classifier are used. Exudates are detected by Morphological operations such as closing, dilation and erosion operators are used Number of micro aneurysm is counted and grade is calculated. Grades and hyper plane representation for multi-classification are used to measure the performance of the system. SVM is better than KNN because SVM provides specificity, sensitivity is more than KNN

2.8 Mohamed Kamelsoliman[8]Assess cone density as a marker of early signs of retinopathy in patients who have type 2 diabetes mellitus. Adaptive optics fundus camera AO allows to capture enface images of photoreceptors in near histological resolution.Cone density in each quadrant across the study groups are used to measure the performance of the system. Measurements are evaluated by ANOVA.Photoreceptor loss correlate with severity of DR which observed low cone density in DR group.It enhances the progression of photoreceptor loss over time.

2.9 Robertorosa-romero[9]The proposed method for MA detection based on i)reduction of non-uniform illuminationii)Normalizationiii)Bottom –hat transform iv) Binarization-ROI v)Hit or miss transformation vi)principle component analysis vii)Radon transform. The techniques are Illumination which detects red lesions, and Non-uniform which detects illumination errors.TP, FP, TN, FN are the parameters which used to measure the performance of the system. The performance can be evaluated using DiaRetDB1 public database and the Retinopathy online challenge (ROC).

2.10 MalavikaBhaskaranand [10]Automated tool for screening DR patients and its extension forestimating the MA turnover via longitudinal analysis.DR screening tool

automatically analyzes color retinal fundus images.MA turnover estimation tool aligns retinal images from multiple encounter of patients and estimates MA turnover rates. This tools are potential biomarker for DR risk.

3. Analysis

S.No	*Techniques and algorithm*	*Parameters*	*Conclusion*
1.	SLO -wide field of view, super pixels, Montaging.	False positive rate True positive rate	It achieve an accuracy of 92% in segmentation of the true retinal area from an SLO image
2.	Trace transforms- application specific functional. SVMkernels and PNN classifiers are used	Accuracy and number of features across different classifiers in In house and open database	This work obtained an accuracy of 99.41 and 99.12% with PNN-GA and SVM quadratic kernels.
3.	Optical coherence tomography (OCT) Anterior chamber angle (ACA) anterior segment OCT (AS-OCT) imaging techniques	Accuracy, F-measure,sensitivity, specificity Between top ranked features in MRMR and L-score.	Unsupervised L-score high accuracy of 86.66% larger feature set. supervised-MRMR method accuracy of 79.32%
4.	Adaptive histogram equalization, CLAHE, Curve let transform, morphological erosion and dilation, Circular fitting method and blood vessels (canny edge detection)	PSNR and MSE in histogram equalization and curve let transform including areas for four images	Better for segmentation of exudates which differentiates diseased persons from normal person.
5.	Preprocessing method, segmentation technique, matched filter and modified local entropy thresholding operation, CLAHE	True positive, False positive, False negative, True negative.	ELM is better than SVM because it provides a specificity, sensitivity accuracy of 96.66%, 100% and 97.5,% 100% and 94.11%,95%
6.	Three-layer feedforward neural network, BPA-Back propagation algorithm, Vessel tracker algorithm.	Grades can be used to measure performance of DR level i) normal ii) moderate iii) severe IV) proliferative.	Accuracy of 80%-correct classification, sensitivity more than 90%,specificity more than 100%
7.	Morphological operations closing , dilation and erosion operators are used Number of MA is counted for grade calculation	Grades, hyper plane representation for multi-classification	SVM is better than KNN because SVM provides specificity 100% and sensitivity is more than 90%
8.	Adaptive optic fundus camera AOallows to capture enface images of photoreceptors in near histological resolution	Cone density in each quadrant across the study groups. Measurements are evaluated by ANOVA	Photoreceptor loss correlate with severity of DR which observed low cone density in DR group. Future work willassess the progression of photoreceptor loss over time.
9.	Illumination-detection of red lesions, Non-uniform illumination-errors	TP,FP,TN,FN are also measured	It achieves a sensitivity specificity and precision of 92.32% 93.87% 95.93% and 88.06%,97.47% 92.19%
10.	DR screening tool MA turnover estimation tool	True positive rate False positive rate	The DR screening tool achieves 90% sensitivity at 63.2% specificity Estimation tool identifies new and disappeared MAs with 100% sensitivity and average false positives of 0.43 and 1.6 respectively

4. Conclusion

A review ondiabetic retinopathy and glaucoma detection from fundus image has been done. It shows that detection of diabetic retinopathy and glaucoma from fundus image are more effective and reduce the need of more ophthalmologists.There are various types of Diabetic retinopathy such as PDR, NPDRor BDR are discussed. Many diabetic retinopathy and glaucoma are detected from fundus images which has retina, optic disc, macular edema, blood vessels.It is observed that removal of optic disc and exudates from fundus images are more efficient way to detect diabetic retinopathy and glaucoma.

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