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A Relative Exploration of Dark and Bright Lesions Segmentation Techniques for Early Detection of Diabetic Retinopathy in Retinal Fundus Images

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***Abstract*—** Popular medical arena, Diabetic Retinopathy stands an oddity that arises into eyes which is gradually expanded and its diagnosis at a primary phase is very critical for retaining vision of several patients. A computerized mass screening of diabetic retinopathy in retinal pictures can assist in diminishing the probability of widespread blindness because of DR together with dropping the work-pressure on ophthalmologists. An automatic identification systems are also accessible which lead to explore numerous eye wounds like micro-aneurysms, haemorrhages , hard exudates and cotton wool exudates by means of colour fundus images. The existence of micro-aneurysms in the retinal images is the most indicative signal of diabetic retinopathy. Stable identification and classification of numerous lesions handle as an important criteria towards automatic grading and severity of the disease. Now we review the diverse previous studies which help in spontaneous diagnose the eye diseases with the intent of affording decision approval in extension to lessening the load of an ophthalmologist.

***Keywords*—** Retinal coloured fundus images, Diabetic Retinopathy, optic disk, Red and bright lesions, image processing techniques, classification.

I. INTRODUCTION

Diabetic Retinopathy (DR) occur an eye syndrome connected with established Diabetes mellitus that leads foundations anomalies in the retina. DR has developed a severe community health issues in advanced nations; meanwhile it is the prominent reason of novel sightlessness and visualization imperfections in working-age individuals. In the preliminary phases of DR, patients are usually symptomless, instead in the further progressive stage; they could involvement indications that contain alteration and blurred visualization. Consequently, initial recognition of DR is decisive on behalf of avoiding vision loss and intended for effective treatment. The efficient technique for examining eye lesions in mass screening systems by means of digital colour fundus pictures in order to inhibiting DR. They generate a superior best of fundus aimed at identifying DR premature signs and evaluating its development. Nevertheless, owing to the growing occurrence of diabetes in the individuals, ophthalmologists essentially inspect an enormous amount of photographs. Consequently, emerging computational implements that can support analyses is of major significance. [1]

When extraordinary glucose damages various vessels in the retina, eyes may leak liquid. It causes the retina to be swelling and determined its stage as early segment of diabetic retinopathy. In corporate with the diabetes, large amount of glucose level intensities in some advanced sections lead to affect tiny blood vessels present in the retina. Basically, human retina encompasses of diverse constituents, such as fovea, macula, blood vessels and optic disc (OD). DR is generally separated into two segments that are invented as Non-Proliferative Diabetic Retinopathy as well as Proliferative Diabetic Retinopathy.

Due to diabetic mellitus (high blood sugar), Diabetic retinopathy might grow over primarily four different platforms:

a) Mild Non-Proliferative Diabetic Retinopathy- Short regions will be expanded by occurrence of swelling in the tiny vessels of the human retina defined as micro-aneurysms described it as starting point of the disease to be occurred. Presence of micro aneurysms can discharge blood or liquid into the area of retina

b) Moderate Non-Proliferative Diabetic Retinopathy-By means, the disorder goes out to be more awful; the retinal veins might be swell and damage. Their ability to conveyance blood may be gone. Both conditions ground the representative variations to the occurrence of the retina.

c) Severe Non-Proliferative Diabetic Retinopathy – It describes the step in which ample of advanced vessels lead to congested and further rejecting supply of blood to

varieties of retina. This kind of affected area may secrete growth variables that standardize the retina will cultivate several new vessels/veins.

d) Proliferative Diabetic Retinopathy- For the duration of this progressive platform, Development variables may lead to expand some new blood veins which developed laterally outside of retina cause to spill the eyes with vitreous gel or some fluid like material. Leakage of fluid/blood is more prone by growth of advanced blood veins/vessels. Most importantly that wound soft tissues will become contract which define the cause of retinal breaks. Retinal separation can lead major to endless vision. [15]

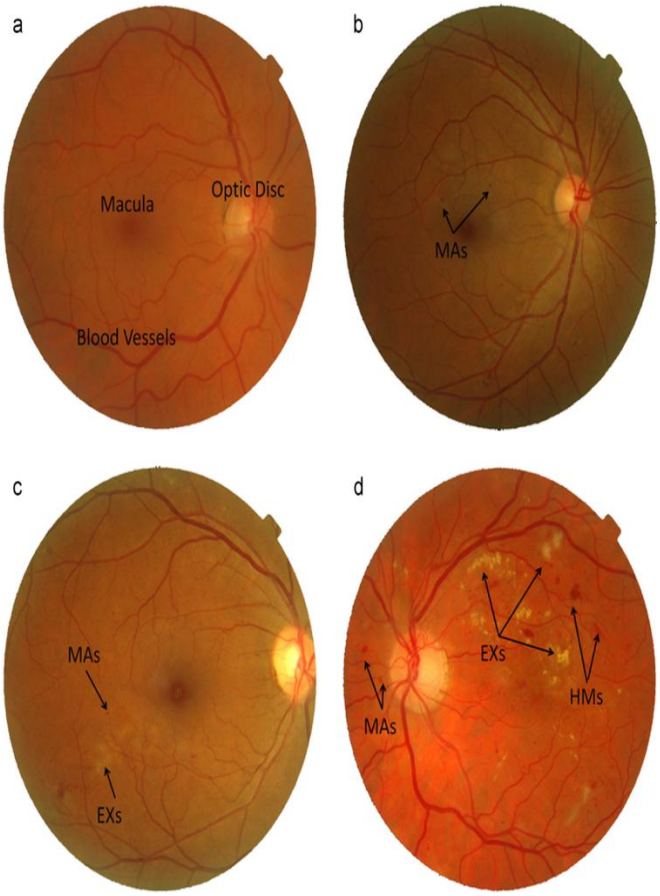

Figure 1: Human Retina associated with Non-proliferative DR platforms: (a) The Normal Retina & its constituents (b) Mild NPDR (c) Moderate NPDR (d) Severe NPDR.

Table 1: Different Stages level of diabetic retinopathy with corresponding lesion's value

Rank/Grade	Stages of Diabetic Retinopathy	Approximations
0	NORMAL STAGE	(ΔA=0) & (Hm=0)
1	MILD	(0≤ ΔA≤5) & (Hm=0)
2	MODERATE	(5< ΔA<15 or 0<Hm<5) & (NeoV=0)
3	SEVERE	(ΔA≥15) or (Hm≥5) or (NeoV=1)

- ΔA= Entire no. of micro-aneurysms.
- Hm = Overall Haemorrhages.
- NeoV = Existence of Neo-Vascularization.

In advance step, the emission of veins in the unmistakable eye, such as the clogged vitreous can achieve near-sincere vision disputes and in the course of extended results in optical harm/ loss. Although, with the support of imaging practices, visual disturbances perceived in the retina would be identified and a set of rules can be established in order to discover these kinds of irregularities. The improvement in automated scenario implements for the discovery of phases of DR has not been very comprehensive since there is no awareness or lack of ophthalmologists. Many pathologies show deviations in colour characteristics, geometric characteristics and texture characteristics, and the finding may be fewer complex and computationally effective through the use of imaging techniques. [2]

II. LITERATURE REVIEW

Here are several latest approaches in the existing works for the precise finding of micro-aneurysms, hard and soft exudates, haemorrhages viewing them independently and in a cooperative mode. Akram et al. proposed a set classifier associated with the m-Mediods-aided classifier approach and the Gaussian mixture model, which lead to improve the performance in term of accuracy of classification mechanism. They used standard databases such as DRIVE, STARE, DIARETDB, MESSIDOR, which led to 98.52 precision in comparison with other classifier methods, established with assistance of statistical performance constraints like sensitivity, specificity, precision and ROC. [1] Franklin and Rajan recommended blood vessel segmentation procedures through the application of a multi-layer perceptron neural network that led to the diagnosis of the degree and severity of the disease at a very early stage. Thus, the backpropagation method is a very clever approach to assigning weights to the direct neural network. This general approach that works in the DRIVE database provides 95.03% accuracy for retinal vessel segmentation and efficiently measures performance. [2] Franklin and Rajan computed the classification of exudates by the practice of artificial neural network (ANN) using different characteristics such as colour, texture, size, shape in order to reveal DR in the background images. [4] Pereira et al. presented a segmentation approach through the use of a novel unsupervised learning mechanism built on the technique of optimization like the ant colony optimization method. Performance parameters are evaluated with the help of the publicly available online dataset, which produces 97.85% accuracy than the existing Kirsch filtering for the detection of exudates in the correct way. [5] Dutta et al. defined the experimental results indicate that a total precision greater than 90% achieved in the existing work and computational density lead to significantly reduced by

using region-based approach. In the region-based approach, the whole image was distributed into regions and the existence of anomalies in those areas specifies the severity of the illness. [6] Kaur et al. proposed an integrated methodology for segmentation of hard lesions by genetic-algorithm and switching-median filtering approach. In this paper, the proposed technique first applies the change of the median filter (Switching-median filter) to eliminate the outcome of high concentrated noise on the fundus images, and then the genetic algorithm will take measures to locate the exudates in these images. The investigational results obviously showed that the existing technique exceeds the presented techniques in terms of sensitivity, precision and error rate. [7] Amin et al. suggested approaches based on pre-processing by applying the Gabor filter to the grayscale image, segmentation of the exudates followed by morphological procedures. The set of characteristics is selected for each applicant lesion using statistical and geometric structures that aid to classify exudates or non-exudates in the background image through the application of various classifiers. This proposed method provides an accuracy of 98.58%, which is higher than the existing methods. [8] Sengar and Dutta presented a categorized model to classify a background image intended for the severity of DR. The lesions were segmented using thresholds based on intensity and morphological practices. In order to distinguish between micro-aneurysms and haemorrhages, several geometrical characteristics have been used. The experimental results achieve classification sensitivity / specificity for bright and red lesions as 97/89% and 94.2 / 84.5%, respectively. The classification of normal images of DR images reaches an average sensitivity / specificity of 93.90 / 76.49%. [9] Issac et al. revealed the practice to automatically detect pathologies and to use them to determine the severity of the disease. They implemented anisotropic diffusion and threshold based on intensity for the diagnosis of bright lesions and performed the corrected shadow method as morphological padding and regional minimal approaches to discard false positives using different characteristics make a less complex procedure and classification followed by SVM. It provides a sensitivity of 92.85% in the DIARETDB1 database and a sensitivity of 86.03% in the MESSIDOR database. [15] Guo et al. planned a method for automatically extracting characteristics and classifying the area of the vessels of the retina using a classifier of two classes, represented as CNN would be trained by a new reinforcement learning procedure with less iteration of time and shorter training time. They offer 91.99% accuracy in the DRIVE database and 92.20% accuracy in the STARE database. [16] Jaskirat Kaur and Deepti Mittal proposed and examined a general method to evaluate the computer-aided significance of the analysis of non-proliferative diabetic retinopathy (NPDR). Performance was evaluated in 5048 clinically obtained retinal images and in open public databases. Experimental consequences for the lesion evaluation demonstrate the great performance of the proposed method for segmenting the dark and shiny lesions with an accuracy of 98.43% and 95.43%, respectively, in the clinically attained retinal fundus images. [17] The outcomes of the evaluation of the images show a high precision in clinically attained ailment images of healthy retinal images, with a typical precision of 100% and 100% for dark as well as light lesions.

III. DIAGNOSIS OF DIABETIC RETINOPATHY VIA IMAGE PROCESSING PRACTISES:

Analysis of diabetic retinopathy by means of several imaging techniques shows a energetic role in the various areas of application of medical images such as Pre-processing practices (Intensity based thresholding, Filtering technique in order to remove noise from images, Background masking, Fuzzy histogram equalization, CLAHE, Colour normalization, Edge enhancement practices), features that will be extracted accordingly and the classification of several DR images using different classifiers such as SVM, Neural network, Naïve Bayesian method, etc.

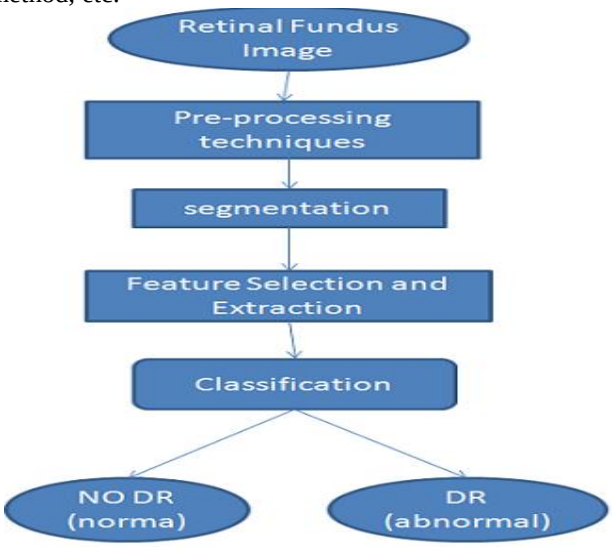

Figure 2: Steps for DR recognition using imaging practices.

3.1. Retinal Images collection:

The first step contain collecting retinal images for the diagnosis of DR from various local hospitals, medical datasets available online, medical labs, etc. and comprise individual data such as the gender, age, symptoms that embrace the results of the laboratory investigation, analysis and treatment they acknowledged.

3.2. Pre-processing Techniques :

Studying the review of different pre-processing techniques in image processing practices, along with the advantages and disadvantages, is discussed in Table 2. The purpose of image pre-processing is to selectively eliminate the redundancy present in the captured images without affecting the details that play a vital role in the general procedure. The

analysis study as described in Table 2, including various pre-processing methods applied over the fundus images.

Table 2: Pre-processing techniques analysis & main characteristics.

Pre-processing techniques Analysis	Features	Advantages	Disadvantages
Background masking [1]	It separates background pixels using a "mean & variance – based method".	It removes image noise by Hue, Saturation and Intensity channels.	It cannot deal with sudden, drastic lighting changes.
Colour Normalization [6]	To amalgamate the colour assets of diverse images.	All images are normalized regarding a reference image.	The pixels become different and do not imitate the actual value of the image colour
Linear filtering: Gabor Filter [7]	This filter is useful for texture analysis and extracting various characteristics.	It is used to de-noise the image and deal with uncovering the edges.	Little power managing ability.
Switching Median filter [7]	This filter classifies damaged pixels.	It leads to eliminate (Impulse) salt and pepper noise from fundus images.	High computation time.
Fuzzy filtering [8]	It is implemented to eliminate Gaussian noise and impulsive noise, while maintaining the edges.	It improves image quality and it performs median filtering, called as Fuzzy Switching Median (FSM).	It requires great computation time.
Fuzzy Histogram Equalization [8]	For better visualization and detection, it is well known as "Brightness preserving dynamic fuzzy histogram equalization" (BPDFHE)	It is useful to improve the contrast of fundus images	Computation time depend on image size.
Curvelet-based edge enhancement [11]	The Curvelet-based transformation is considered as proficient, for identify edges of horizontal, vertical & diagonal areas, directional data, contours, curvatures, etc.	It assisted for detecting edges of dark lesions presented in background.	Estimates are not well accurate.
CLAHE (Contrast Limited Adaptive Histogram Equalization) [12]	Contrast-limiting practices should be applied to each neighbor from whom a transform function is generated.	It is useful for increasing contrast and introducing huge deviations in gray pixel values.	It is moderately complex method.
Anisotropic Diffusion / Perona-Malik Diffusion [15]	It reduces noise devoid of eliminating major properties of image, as borders, lines or other details that required for image interpretation.	Edges can be preserved while the noise in the image is removed. Hence, anisotropic diffusion can be used in edge detection algorithms.	Sometimes, it produced unsatisfactory results.

Basically, these techniques lead to preserve the edges while de-noising filtering practices are applied, as anisotropic diffusion and also increase the contrast of the images at very precise range by using fuzzy histogram equalization as well as CLAHE. The main goal of pre-processing methods is to keep all necessary details in the fundus images which are further significant for features extraction in a tremendous way.

3.3. Feature Selection and Extraction

The function is actually a critical step for the classification of the colour fundus images. Resource extraction methodologies evaluate pre-processed images to extract key features that represent different sets of features based on pixel intensity rate statistics. Each feature set includes individual image parameters. These characteristics may vary according to distinct medical applications. For example, for After applied rendering to the advantages, it preserves a better image and the visual quality of the input image. automated finding of illness (DR) in fundus images, some characteristics related schemes are explained in Table 3.

Table 3: Feature extractions practices.

Extracted Features	Descriptions	Mathematical Representation
1. Contrast	Contrast in the intensity of the pixel and its neighbor on the candidate region.	f1(x,y)= $\sum a \sum b(a-b)^2 p(x,y)$
2. Energy	Sum of the GLCM square elements for the image of the candidate region.	f2(x,y)= $\sum p(x,y)^2$

3.	Homogeneity	The proximity of the division of the GLCM elements to its diagonal.	f3(x,y)= $\sum i \sum j \left(\frac{p(x,y)}{1+\lvert i-j\rvert}\right)$
4.	Area	Quantity of pixels in the likely aspirant region.	f4(x,y)= $\sum_{i=x}^{x+width} \sum_{j=height}^{y=height} S(i,j)$
5.	Eccentricity	The distance between the ellipses foci divided by its main axis.	$\frac{1}{L1}\sqrt{L1^2 + L2^2}$, Where L1 and L2 are major and minor axis.
6.	Perimeter	Distance about the edge of the candidate region	$\sqrt{(x2-x1)^2 + (y2-y1)^2}$
7.	Aspect ratio	Ratio amongst major & minor-axis of the applicant area.	P=$\frac{l}{w}$, Where l is the length of the largest and w is the second largest eigenvalue of the candidate region convariance matrix.
8.	Compactness	Defines circularity of the candidate pixels.	M = $4\,\pi \left(\frac{Area}{Perimeter^2}\right)$
9.	Gabor filter bank	It is used to extract the appreciated texture features in the retinal fundus images.	$g_{\Theta,\lambda,\sigma1,\sigma2}$(x,y)= $\exp\left\{\frac{j\pi}{\lambda}(xcos\Theta + ysin\Theta)\right\}$, where M=diag(σ_1^{-2}, σ_2^{-2}), Θ = filter orientation, λ =filter wavelength, σ_1, $\sigma_{2\ denotes}$ standard deviation.
10.	Filled Area	Candidate pixel with its neighbouring predefined in square region.	Filled area= $S^2 \subset R^3$
11.	Wavelet correlation	Calculate correlated gray-level elements in the coefficient matrices	$Correlation_{wave=}$ $\frac{(1-\mu x)(1-\mu y)Ca(x,y)}{\sigma x \sigma y}$ Where μx, μy, σx, σy are mean and Standard deviation.
12.	Roundness	It is a measure of how close the shape of an object approaches a mathematically perfect circle.	r = $\frac{4\pi A}{P^2}$, Where A, P denote area and Perimeter

1.1. Classification Techniques

Classification practices explore the study and construction of algorithms that can study and predict data. These algorithms focus on forecasting, based on known properties, such as the supervised dataset, which is learned from training data that is shown as:

1.1.1. Support-vector machine (SVM) :

SVM follow Supervised-learning approach intended to perform classification as well as regression for different lesions existing in the fundus images. It defines a type of classifier that uses features extracted from the disease-specific region to classify and determine the degree and severity of diabetic retinopathy for each image of the retinal fundus. The key indication in SVM is to make a hyperplane in an infinite space and a space of high dimension. Classification criteria are used to identify the class to which the data belongs. Regression norms are used to predict the value of the target variable.

1.1.2. K-nearest Neighbour (K-NN method):

The K-nearest Neighbour procedure performs to be defined as non-parametric scheme, which is mainly approved for both practices as regression and classification. Main objective followed by this method, is to give some weightage contribution of neighbouring pixels that lead to be more typical than more reserved neighbours. Basically, neighbouring pixel values perceived from a bag of objects that give assistance for class to be known (for the k-NN classification) or the assets value of the object (for the k-NN regression). It is also sensitive to the local organization of the data.

1.1.3. Artificial neural-network (ANN):

The neural-network is essentially stimulated by biological neural networks that are immensely parallel computing organizations that comprise of a great number of simple processing elements with numerous interconnections called nodes or neurons that are prescribed in a normal manner. This method is like people learning through examples that make them very flexible and powerful. It lead to classify the retinal fundus images, whether there is presence of disease or not more accurately.

1.1.4. Gaussian-mixture model:

For classifying, dark and light lesions according to the assignment of candidate regions, we used a 2-class Bayes classifier via Gaussian functions recognized as per the Gaussian-mixture model. Several restrictions for GMM increased by means of expectation-maximization (EM), lead to a recursive mode which corresponds the maximum local significance of the GMM circulations aided for training data-set, selecting most suitable limits.

1.1.5. Convolution Neural Network (CNN):

Basically, convolutional neural network presented a form of deep & artificial neural-network, which is commonly used to analyse visual fundus images. It uses a wide-range of multi-layer perceptron intended towards slight improvement in pre-processing. A single CNN comprises - input-output layer & numerous hidden layers. Fewer hidden layers generally

contain of convolutional layers, grouping layers (Pooling Layer), Fully-connected layers, and normalization layers. CNN model has an ability to recognize the retinal images, whether the individuals suffered from DR or not.

The review analysis of Table 4 focuses on the various advantages as well as disadvantages of existing methodology which identifies slightly low accurate results. In order to gain more accurate results, we have to discover novel hybrid classifiers that mainly elaborate improvement in parameters associated with performance i.e. accuracy rate, error rate, specificity rate, sensitivity rate analysis.

Table 4: Several classification methodology with its benefits and limitations.

Classification techniques	Advantages	Disadvantages
1.Support Vector Machine (SVM)	Very effective in high dimensional data space, high performance, memory efficient, versatile.	Difficult to interpret due to Black box prototype, High parametric dependencies.
2. K-Nearest Neighbour (KNN)	Simple, Dynamic in nature (can work on any distance measure), Non-parametric model, training time is not required.	Requires well training dataset, complex to k-value selected, and memory exhaustive.
3. Artificial Neural Network(ANN)	Self-organized model, fast method, easy to interpret, powerful.	High complexity, need large training time, high dependencies.
4.Gaussian Mixture Model (GMM)	Robust, well handling unknown values, compatible to irrelevant factor value.	Large dependencies, accuracy loss.
5. Convolution Neural Network (CNN)	Powerful scheme, high accuracy, Simple logistic, High prediction rate.	No clear interpretation, slow training and detection as well.

IVCURRENT RESEARCH PAPERS INVESTIGATE DR DETECTION PRACTICES USING IMAGE-PROCESSING APPROACH

Many ophthalmologists showed their innovative skills regarding imaging approaches because of large patient dataset. They discover some advantages in order to reduce the training time, fast learning skills, better performance, and efficient results. Table 5 shows the advantages as well as disadvantages of mainly 14 review papers. Table 6 presents relevant techniques corresponding to the several image processing and classification methods ever since 2014 and up-to 2018.

Table 5: Several Techniques with Parameter Values.

Ref. no	Author	Year	Techniques	Parameters	Benefits	Limitations
[1]	M. Usman Akram, Shehzad Khalid, Anam Tariq, Shoab A. Khan, Farooque Azam	2014	GMM classifier, m-Mediods classifier, morphological operations.	Overall Accuracy = 98.52%	Hybrid classifier ensure to introducing finest properties of both, high accuracy.	High computation time.
[2]	Franklin SW, Rajan SE	2014	ANN, Contrast enhancement, Back-propagation method,	Sensitivity = 96.3%, Specificity = 99.8%, Accuracy = 99.7%	High ability to learn, easy, Accuracy ∝ training samples.	Features extraction is not properly explained.
[3]	Usman Akram, Anam Tariq, Shoab A. Khan, M. Younus Javed	2014	GMM classifier, SVM, Contrast enhancement techniques, Binarization.	Sensitivity = 97.3%, Specificity = 96.9%, Accuracy = 96.8%	Improved performance, high accuracy,	Complex computations.
[4]	S. Wilfred Franklin, S. Edward Rajan	2014	Neural network, Back-propagation method, Vessel segmentation.	Accuracy = 95.03%	High ability to diagnose automatically.	Other features related to DR must be introduced.
[5]	Carla Pereira, Luís Gonçalves, Manuel Ferreira	2015	Filtering technique, Normalization, ACO algorithm, Edge enhancement.	Sensitivity = 80.82%, Specificity = 99.16%, Accuracy =97.85% PPV= 73.01%	High Edge enhancement, better accuracy results due to pixel based approach.	This approach is not based on early stage detection of illness.
[6]	Dutta MK, Partha Sarathi M, Ganguly S, Ganguly S, Srivastava K	2015	Intensity threshold, segmentation, morphological operations.	Overall Accuracy = 90%	Low computational complexity, fast diagnosis approach.	Inadequate technique for detecting proliferative DR.

[7]	Amanjot Kaur, Prabhpreet Kaur	2016	Switching Median Filter, Genetic Algorithm based segmentation, Ant Colony optimization (ACO) technique.	Sensitivity = 99.75%, Accuracy =99.05% Error rate= 0.0120	De-noise image well, reject high rate of false positives, high accuracy, fast and powerful methodology.	For better performance, hybridization is must with ACO and GA.
[9]	Sengar N, Dutta MK	2017	Combination of intensity thresholding and morphological technique.	(for bright lesions) Sensitivity = 97%, Specificity = 89%, (for red lesions) Sensitivity = 94.2%, Specificity = 84.5%, (for normal images) Sensitivity = 93.90%, Specificity = 76..49%,	Require less computation time and evade same multiple calculations.	More features must be identified for improvement in accuracy.
[10]	Javeria Amin, Muhammad Sharif, Mussarat Yasmin, Hussam Ali, Steven Lawrence Fernandes	2017	Gabor filter, segmentation, morphological operations, KNN, SVM, Logistic regression,	Accuracy = 98.58% (Area under curve) AUC = 98%	Increase accuracy, time saving approach.	This work must be extended its scope w.r.t. severity of ailment.
[11]	Sarni Suhaila Rahim, Vasile Palade, James Shuttleworth , Chrisina Jayne	2017	Fuzzy Filtering, Fuzzy Histogram Equalization, Fuzzy Edge Detection , Global Thresholding, KNN, SVM, Naive Bayesian method.	Accuracy = 93% (KNN and RBF-SVM) Specificity = 100% (KNN) Sensitivity = 92.45% (RBF-SVM) Misclassification Error = 0.2500	Efficient, Fast training speed, cost effective, robust method and also introduce new dataset.	More fuzzy techniques can be applied for better performance.
[12]	M.M. Habi, R.A. Welikala, A. Hoppe, C.G. Owen, A.R. Rudnicka, S.A. Barman	2017	Pre-processing, Tree ensemble classification,	ROC value = 0.415 (For Naïve Bayes approach)	Increase efficiency and lessen the problem of overfitting.	Some of the features are ignored, due to lack of information perceived.
[14]	Pedro Costa, Adrian Galdran, Asim Smailagic, and Aurelio Campilho	2018	Multiple instance learning (MIL) frame, bag of features,	(for MESSIDOR) AUC=90 % (for DR1) AUC=93 % (for DR2) AUC=96 %	Highly interpretable, Better understanding, optimized technique.	Several bag instances are unknown with variability in dimensional criteria.
[15]	Ashish Issac, Malay Kishore Dutta, Carlos M.	2018	Segmentation, Anisotropic Diffusion, Intensity based Thresholding, Shade Correction method, Binarization, SVM.	(On DIARETDB1 dataset) Sensitivity = 92.85% (On MESSIDOR dataset) Sensitivity = 86.03%	Very robust to eliminate the false positives correctly, less complex, effective technique.	Less textural features presented.
[16]	Yanhui Guo, Umit Budak, Lucas J.Vespa, Eiham Khorasani, Abdulkadir Sengur	2018	CNN, Vessel segmentation, Reinforcement learning technique.	(On DRIVE dataset) Accuracy = 91.99% AUC score = 96.52% (On STARE dataset) Accuracy = 92.20% AUC score = 94.40%	Better performance, training speed is fast, accurate results.	No pre-processing phase take place.

[18]	Manish Sharma, Praveen Sharma, Ashwini Saini and Kirti Sharma	2018	Modular Neural network (MNN), Discrete Cosine transform (DCT).	Accuracy = 100% (for normal images)	High training ability, decent classification rate.	Mass dependent approach, slow method, accuracy must be improved.

V GAPS RELATED TO LITERATURE REVIEW

The following research gaps on the work were identified through the literature related to the countless methodologies which give benefit for DR analysis from numerous fundus images using various imaging techniques:

- Scarcity taken place in existing research work for evaluating the high grade diabetic retinopathy as proliferative diabetic retinopathy.
- The squeezing structure that comprises novel processes in order to expand subsequent processing in imaging techniques remains lost.
- Vigorous practices aimed for extracting the valuable features from the fundus images that assist towards improvement in prediction have not yet designed accordingly.
- According to the application domain, successive robust methods for post processing in digital image processing using several techniques are quite misplaced.
- The Optimization procedures like ant-colony optimization, genetic algorithm, etc were not recommended in order to lessen the level of noise.
- In real life projects, live datasets for particular area of interest are not easily provided to the researchers with the intention of improvement in accuracy factors using hybrid classifiers.
- Lack of performances for finding the textural features accordingly which assist in improvement for detection as well as severity of the ailment in a correct manner.

Table 6: Evaluation of Image processing & classification methods with its corresponding database.

Title, Author and Publication	Dataset	Features	Tool / techniques	Classification approach
Title: "Blood Vessels Segmentation with GUI in Digital Fundus Images for Automated detection of Diabetic Retinopathy" Authors: "Deepashree Devaraj and Dr. Prasanna Kumar S.C." Publication: "Contemporary Computing and Informatics. (2014)"	Retinal fundus images from DRIVE database of size 768×564 pixels in JPEG format.	Area, Mean, Standard Deviation, Energy, Entropy and Histogram.	Vessels detection techniques such as : Canny Edge Detection procedure. Kirsch's Edge System. Adaptive Entropy Threshold Algorithm Maximum Minimum Limit Algorithm Adaptive Mean Threshold Algorithm Adaptive Median Threshold Algorithm	Adaptive Median Thresholding Technique.
Title: "Detection and classification of retinal lesions for grading of diabetic retinopathy" Authors: "M. Usman Akram, Shehzad Khalid, Anam Tariq, Shoab A. Khan, Farooque Azam". Publication: "Elsevier (2014)."	DRIVE, STARE, DIARETDB, MESSIDOR.	Area, Perimeter, Energy, Eccentricity, Intensity, Aspect Ratio, Compactness, Mean HSV, Mean Enhanced Intensity, Mean Gradient Magnitude, Mean Box Gradient, Third Moment, Entropy, Mean Range Filter.	Pre-processing techniques, filtering approach, m-Mediods classifier, Gaussian mixture model (GMM) classifier, morphological operations.	A novel ensemble classifier as m-Mediods with Gaussian mixture model, used to improve the accuracy of the classification approach.
Title: "Computerized screening of diabetic retinopathy employing blood vessel segmentation in retinal images" Authors:" S. Wilfred Franklin, S. Edward Rajan" Publication: "Elsevier (2014)"	DRIVE database of size 768×564 pixels in JPEG format.	Intensity related features mined.	Background Normalization, CLAHE, Vessel Segmentation, Neural Network.	Back-propagation algorithm provides a valuable classification aspect of vessels, show with excellent performance and efficiently implemented.
Title: "Automatic detection of microaneurys	DIARETDB0, DIARETD	Area, Mean, Standard Deviation,	Vessel Segmentation, K-Nearest	Circular Hough Transformation

ms in colour fundus images For diabetic retinopathy screening" Authors: "Sarni Suhaila Rahim, Chrisina Jayne, Vasile Palade and James Shuttleworth" Publication : "Springer (2015)"	B1	Perimeter, Major Axis Length, Minor Axis Length, Aspect Ratio, and Circularity.	Neighbor, SVM Polynomial Kernel, RBF Kernel SVM, Shade Correction Method, Circular Transformation and Fuzzy Histogram Equalization.	Technique (CHT) used for detecting micro-aneurysms. Fuzzy preprocessing tasks provide better contrast enhancement that assist in detection of microaneurysms .
Title : "Exudate segmentation in fundus images using an ant colony optimization approach" Authors: "Carla Pereira, Luis Goncalves, Manuel Ferreira" Publication: "Elsevier (2015)"	169 images taken from the novel dataset i.e. (HEIMED)	ACO based features extracted.	Filtering technique, Normalization, ACO algorithm, Edge enhancement.	In detection of exudates, ACO algorithm perform better results than Kirsch filter.
Title: "An Integrated Approach for Diabetic Retinopathy Exudate Segmentation by Using Genetic Algorithm and Switching Median Filter" Authors:"Amanjot Kaur, Prabhpreet Kaur" Publication: "Image, Vision, and Computing (2016) "	28 retinal images take from CHASE database in TIFF format.	Features extraction by using morphological operations.	Switching Median Filter, Genetic Algorithm based segmentation, Ant Colony optimization (ACO) technique.	Exudates segmentation using Genetic algorithm optimization technique, features extraction and then evaluate performance metrics.
Title: "Automatic screening and classification of diabetic retinopathy and maculopathy using fuzzy image processing" Authors:"Sarni Suhaila Rahim, Vasile Palade, James Shuttleworth and Chrisina Jayne" Publication: "Springer (2016)"	600 colour fundus images collected from Hospital Melaka, Malaysia size of 3872×2592 pixels in JPEG format.	Area, mean, standard deviation.	Fuzzy Filtering, Fuzzy Histogram Equalization, Fuzzy Edge Detection, Global Thresholding, KNN, SVM, Naive Bayesian method.	Combining fuzzy image processing practices, circular transformations, and various methods of extracting resources from the nearest neighbor, RBF kernel SVM yield more accurate screening system.
Title: "Automated method for hierarchal detection and grading of diabetic retinopathy" Authors: "Namita Sengar & Malay Kishore Dutta" Publication: "Computer methods in biomedical Engineering: Imaging and Visualization. (2017)"	154 colour fundus images from local hospital. 1200 retinal images from MESSIDOR database.	Features mined as local statistical characteristics and geometrical characteristics such as the length of the major axis & minor axis, the diameter, the ratio of the length of the major axis as well as minor axis.	Combination of Intensity based thresholding, Morphological operations, Adaptive Histogram Equalization.	Image acquisition, Bright lesion detection using Intensity based Thresholding and morphological operation. Red lesions detection by Intensity based Thresholding and geometrical features which assist in classification the grade of DR.
Title: "Automatic computer vision-based detection and quantitative analysis of indicative parameters for grading of diabetic retinopathy" Authors: "Ashish Issac, Malay Kishore Dutta, Carlos M. Travieso" Publication : "Springer (2018)"	DIARETDB0, MESSIDOR.	Statistical features : Mean, Standard Deviation, Variance. Geometrical features: Area, Perimeter, Solidity, Eccentricity, Aspect Ratio. Location Independent features: Distance from OD, Slope from OD.	Segmentation technique, Anisotropic Diffusion, Intensity based Thresholding, technique, Shade Correction method, Binarization, Flood Fill operation, SVM (Support Vector Machine).	Optic disc segmentation and removal by average filter, OD centre marked as Circular mask to remove OD pixels. Exudates segmentation and classification by anisotropic diffusion, intensity based thresholding, SVM. Red lesions segmentation and classification by Shade Correction method and morphologic

				al flood fill technique, SVM
Title: "A retinal vessel detection approach using convolution neural network with reinforcement sample learning strategy" Authors:"Yan hui Guo, Umit Budak, Lucas J.Vespa, Eiham Khorasani, Abdulkadir Sengur" Publication: "Elsevier (2018)"	DRIVE, STARE.	Act as two-class classifier to extract different features.	Convolution neural network, Reinforcement learning technique, Vessel Segmentation.	CNN model employing a unique learning approach with less iteration of epochs and yield higher accuracy with less training time.

VI RESULT AND CONCLUSION

This paper will focus on analysis of different techniques related to CAD-DR diagnosis by side with several imaging practices and classification approaches that lead to expand methodical decisive conditions tremendously.

It demonstrate the system which perform consistent grading and severity of the DR levels in several retinal fundus images by means of imaging techniques as pre-processing, segmentation, feature extraction and then classification methodology. Deliberately, the classification of the affected images is done in a mild, moderate and severe manner. Also, all kind of the abnormalities in NPDR are measured specifically as bright and dark lesions that make the method an integral structure for the diagnosis of DR. In imaging techniques, several pre-processing steps assist to generate background mask for dealing out further processing only on some foreground set of pixel values. Several parts of retina of the eye i.e. optic disk, blood vessels, etc might be extracted in this first region of step. Next step as feature selection and extraction by applying different filters, techniques related to texture, gray level, Local binary pattern (LBP), Markovian random field (MRF), statistical, etc. And then accordingly, each particular region corresponds to ailment's characteristics developed by classifiers for obtaining accurate results.

Experimental outcome attain in the form of sensitivity, specificity, accuracy, AUC (area-under curve), error-rate. We demonstrate that hybrid classifiers lead to provide best precise results, less error rate generated as compared to other techniques.

We conclude that performing collaboration of several techniques related to image processing and classification, make possible to give more efficient outcome in less computational time, fast training speed as well.

REFERENCES

[1] M. Usman Akram, Shehzad Khalid, Anam Tariq, Shoab A. Khan, Farooque Azam, "Detection and classification of retinal lesions for grading of diabetic retinopathy", proceeding in Computers in Biology and Medicine. Elsevier 45(2014), pp: 161–171, Doi: 10.1016/j.compbiomed.2013.11.014

[2] Franklin SW, Rajan SE (2014) "Diagnosis of diabetic retinopathy by employing image processing technique to detect exudates in retinal images", IET Image Proc 8(10), pp: 601–609, Doi: 10.1049/iet-ipr.2013.0565

[3] Usman Akram, Anam Tariq, Shoab A. Khan, M. Younus Javed, "Automated detection of exudates and macula for grading of diabetic macular edema" proceeding in computer methods and programs in Biomedicine 114 Elsevier (2014), pp: 141-152, Doi: 10.1016/j.cmpb.2014.01.010

[4] S. Wilfred Franklin, S. Edward Rajan, Computerized screening of diabetic retinopathy employing blood vessel segmentation in retinal images, Bio-cybernetics and Biomedical Engineering, Elsevier 34 (2014), pp: 117–124, Doi: 10.1016/j.bbe.2014.01.004

[5] Carla Pereira, Luís Gonçalves, Manuel Ferreira," Exudate segmentation in fundus images using an ant colony Optimization approach" proceedings in Information Sciences, Elsevier 296 (2015) pp:14–24, Doi: 10.1016/j.ins.2014.10.059

[6] Dutta MK, Partha Sarathi M, Ganguly S, Ganguly S, Srivastava K (2015) An efficient image processing based technique for comprehensive detection and grading of non-proliferative diabetic retinopathy from fundus images, Computer Methods in Biomechanics & Biomedical Engineering: Imaging & Visualization 5(3), pp: 195–207, Doi: 10.1080/21681163.2015.1051187

[7] Amanjot Kaur, Prabhpreet Kaur, "An Integrated Approach for Diabetic Retinopathy Exudate Segmentation by Using Genetic Algorithm and Switching Median Filter" , proceeding in Image, Vision and Computing, Inter. Conf. IEEE (2016), Doi: 10.1109/ICIVC.2016.7571284

[8] Sarni Suhaila Rahim, Vasile Palade, James Shuttleworth, Chrisina Jayne, "Automatic screening and classification of diabetic retinopathy and maculopathy using fuzzy image processing", Springer (2016), Doi: 10.1007/s00521-015-1929-5

[9] Sengar N, Dutta MK, "Automated method for hierarchal detection and grading of diabetic retinopathy" Computer methods in biomechanics and biomedical engineering: imaging and visualization. Taylor & Francis Publishers (2017), pp 1–11, Doi: 10.1080/21681163.2017.1335236

[10] Javeria Amin, Muhammad Sharif, Mussarat Yasmin, Hussam Ali, Steven Lawrence Fernandes , "A Method for the Detection and Classification of Diabetic Retinopathy Using Structural Predictors of Bright Lesions" proceedings in Journal of Computational Science, Elsevier 19 (2017), pp: 153-164, Doi: 10.1016/j.jocs.2017.01.002

[11] Sudeshna Sil Kar and Santi P. Maity , "Automatic Detection of Retinal Lesions for Screening of Diabetic Retinopathy" proceedings in IEEE Transactions on Biomedical Engineering, (2017), Doi: 10.1109/TBME.2017.2707578

[12] M.M. Habi, R.A. Welikala, A. Hoppe, C.G. Owen, A.R. Rudnicka, S.A. Barman, "Detection of microaneurysms in retinal images using an ensemble classifier" proceedings in Informatics in Medicine Unlocked, Elsevier 9 (2017), pp: 44–57, Doi: 10.1016/j.imu.2017.05.006

[13] Sumathi Thangaraj, Vivekanandan Periyasamy, Ravikanth Balaji, "Retinal vessel segmentation using neural network" proceedings in IET image processing (2017), Doi: 10.1049/iet-ipr.2017.0284

[14] Pedro Costa, Adrian Galdran, Asim Smailagic, and Aurelio Campilho, "A Weakly-Supervised Framework for Interpretable Diabetic Retinopathy Detection on Retinal Images", IEEE (2017), Doi: 10.1109/ACCESS.2018.2816003

[15] Ashish Issac, Malay Kishore Dutta, Carlos M., "Automatic computer vision-based detection and quantitative analysis of indicative parameters for grading of diabetic retinopathy" proceedings in advances in bio-inspired intelligent systems: Neural Computing and Applications. Springer (2018), Doi: 10.1007/s00521-018-3443-z

[16] Yanhui Guo, Umit Budak, Lucas J.Vespa, Eiham Khorasani, Abdulkadir Sengur, " A retinal vessel detection approach using convolution neural network with reinforcement sample learning strategy", Measurement , Elsevier 125 (2018),pp:586–591,Doi: 10.1016/j.measurement.2018.05.003

[17] Jaskirat Kaur, Deepti Mittal, "Estimation of severity level of non-proliferative diabetic retinopathy for clinical aid" Biocybernetics and Biomedical Engineering , Elsevier, 38(2018), pp: 708-732, Doi: 10.1016/j.bbe.2018.05.006

[18] Manish Sharma, Praveen Sharma, Ashwini Saini and Kirti Sharma, "Modular Neural Network for Detection of Diabetic Retinopathy in Retinal Images" proceedings in Innovations and Computing, Smart Innovation, Systems and Technologies 79, Inter. Conf. on smart systems, Springer (2018), Doi:10.1007/978-3-319-67934-1_2

