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Neural Network Technique for Diabetic Retinopathy Detection

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Abstract: ***The diabetes retinopathy is the application of medical image processing. The retinal images are evaluated to diagnose the DR. It is however, time consuming and resource demanding to manually grade the images such that the severity of DR can be defined. When the tiny blood vessels present within the retina are damaged, only then can one notice this problem. Blood will flow from this tiny blood vessel and features are formed from the fluid that exists on retina. The kinds of features involved here due to the leakage of fluid and blood from the blood vessels are considered to be the most important factors to study this problem. The diabetes retinopathy detection techniques has the three phase which pre-processing, segmentation and classification. In this work, NN approach is used for the classification of diabetes portion from the image. The proposed model is implemented in MATLAB and results are analyzed in terms of certain parameters***

Keywords: Diabetes retinopathy, NN, Optical Disk Segmentation

I. INTRODUCTION

An image is created with the collection of several 2-dimensional and 3-dimensioanl spaces. The medical images include several kinds of measurements among which some are the RF signal amplitude in MRI, the acoustic pressure found in ultra sound images or the radio absorption in X-ray imaging. If a single measurement is performed at each location available in the image, it is known to be scalar. To control the high level of imaging, it is important to design adequate software. Therefore, based on the partial differential equations and curvature driven flows, new algorithms have been designed by signal and image processing technology [1]. It is easy to collect different medical images since there are several techniques present all across the biological sales. The modern medical images are known to be the geometrically arranged arrays of data samples which quantify the diverse physical properties. There has been huge expansion in the bio physical world which has resulted in growing the scope of imaging based on observations [2]. Thus, the ability of applying new processing techniques is also increasing. For controlling the functioning and nonfunctioning of physiologies, it is important to create complex mathematical models and to do so, multiple channels have been integrated. It is important to create such software techniques through which the complete therapy delivery systems can be combined.

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Retina is a part of human eye which faces a disease commonly called Diabetic retinopathy (DR). In case if the disease is not cured and it keeps growing, a person might be affected with complete blindness [3]. The developing countries do not have enough trained ophthalmologists and people are also not aware of such disease. In case if proper treatment and some automated tools have been generated, initial care can be provided to patients and the disease can be prevented from growing to further stage [4]. Some effective solutions have been provided to identify DR from images although they include early diagnosis and continuous monitoring of diabetic patients. DR is diagnosed by evaluating the retinal images of patients captured over time. However, the manual grading of images to define the severity of DR is very time consuming and resource demanding. This major problem can only be noticed when the tiny blood vessels in the retina begin to damage. This tiny blood vessel causes the blood flow and fluid present in retina results in forming features [5]. After the disease starts growing to the next level, oxygen enters in between the retina and clouding vision because of the generation of new blood vessels. In case of diabetic patients, it is important to conduct regular screening to keep in track the growth of DR disease. The presence of an automatic or computer-aided analysis can make it very easy for a specialist to observe the retina of diabetic patients clearly [6]. The diabetic retinopathy is quantified and features are recognized so far, on the fundus images. Even when it is possible to analyze few particular features of retina, a reliable or robust technique has not been derived by researchers yet. A three-step algorithm is designed which helps in calculating the severity of DR and automatically grade it. The ophthalmic fundus images are used in this automatic process [7]. The preprocessing stage includes few issues such as image blurriness, non-clarity or problems related to image size. In the initial step, the image is resized and then the color space conversion and image restoration steps are performed further. The final stage includes the enhancement of image [8]. In the color space conversion process, the color fundus input image is transformed into HSI (Hue, Saturation and Intensity). HSI format includes decoupling of color model space from the color images. The first step performs histogram equalization which is followed by contrast enhancement. In the preprocessing step, the pixel intensities are then scaled [9]. The candidate extraction process includes performing different morphological operations for recognizing the micro-aneurysms and exudates features. The invert image technique is applied to invert the image. The holes are then filled in the image towards the end. Optical disc is the brightest part of a normal eye in the fundus images. The shape of this part is either oval or elliptical [10].

In case of colored fundus images, the optical disc is presented as a bright yellow or white area. The exudates include high and similar intensity values for the optic disc. Therefore, it is very necessary to remove the optic disc from the retinal image. The brighter optic disc can be masked and removed with the help of region properties and area recognition processes [11]. For the detection of micro-aneurysms and exudates from retinal images, it is important to remove the blood vessels and optical disc from it since the concentration levels of all of these features are same. On an intensity image, dilation is applied so that the high levels contrasts vessels available in blood can be removed. After the removal of blood vessels and optical disc from the image, it is possible to identify the exudates features. Exudates are the bright lesions existing in a retina image. Such important features are recognized by applying the morphological closing operation [12]. After recognizing the exudates and micro-aneurysms present in a color image, the features can be extracted from the fundus image. All the features are calculated and different classifiers are used to which these output values are given as input. Some of the commonly used classifiers in this process are explained further. The SVM (Support Vector Machine) classifier is commonly known for handling mostly the binary classification issues. This classifier studies the multi-class pattern recognition issue [13]. The calculation of k-nearest neighbor classifier value is done based on the Euclidean distance which is present in between a test sample and the specific training samples. Naïve Bayes Classifier is designed on the basis of Bayes Theorem and the assumption that there are independent predictors. Neural Network is comprised of neurons that self-optimize through learning [14]. Each neuron will still receive an input and perform an operation (such as a scalar product followed by a non-linear function) the basis of countless Artificial Neural Networks (ANNs).

II. LITERATURE REVIEW

Karami, et al. (2017) proposed an automatic DR detection approach for digital fundus images which was a dictionary learning (DL)-based approach [15]. This detection approach was generated based on the best atomic representation of fundus images depending on the learned dictionaries created using K-SVD algorithm. The region of class which included the least numbers of best particular atoms was considered to include the test image. Based on the conducted experiments and achieved outcomes it was seen that around 70% accuracy was achieved for normal images and 90% of accuracy was achieved for diabetic images when the proposed technique was tested on 30 color fundus images.

Carrera, et al. (2017) proposed a novel approach using digital processing to detect the DR from retinal images at initial stage so that it can be controlled [16]. This approach aimed to classify the grade of NDPR in the retinal image in automatic manner. The performance of proposed approach was tested on a database which included 400 retinal images. Based on the 4-grade scale, the images were categorized by this proposed approach. Through the experimental results it was seen that around 94% of predictive capacity and 95% of sensitivity were achieved as output. Higher robustness was also achieved by this proposed approach as per the evaluations performed at the end of this research.

Rao, et al. (2016) proposed a hybrid approach to detect the Microaneurysms and Exudates from retinal fundus images in which the Fuzzy C-means clustering and morphological processing were combined [17]. The proposed approach helped in segmenting the blood vessel and the morphological operations. The images were categorized by applying SVM classifier. This algorithm performed classification on the basis of certain parametric values. Evaluations were performed based on specificity, accuracy and sensitivity which showed that the improvement was of achieved to next higher level.

Yadav, et al. (2016) studied the various fundus image enhancements techniques that were applied to identify DR. A comparative analysis of these different techniques was performed in this research. It was seen that the few common issues faced in medical images involved poor contrast, non-uniform illumination and presence of noise. Thus, initial steps involved image pre-processing [18]. Several techniques like ESIHE, HE, CLACHE and so on were applied in this process, which were all compared here. For performing performance evaluations, the proposed technique was implemented in MATLAB simulator. The end results showed a fair analysis of various parametric values for various techniques.

Gupta, et al. (2016) proposed a novel approach for discovering the vessels [19]. This approach included various existing approaches which were of less quality and had an estimated locale for the macula position. With the application of Gaussian channel along with morphological administrator, highly efficient results were achieved which had the least computational time. For improving the exactness of proposed technique in future, this work could be extended by generating the edge values which include autonomous image properties.

Seoud, et al. (2016) proposed a novel approach for detecting and validating the microaneurysms and hemorrhages automatically from the color fundus images [20]. A new set of shape features which are categorized without including precise segmentation of regions were known as dynamic shape features. The per-lesion and per-image were validated using six different databases. The robustness of proposed approach was validated based on the variability of image resolution, quality and acquisition system. It was seen that the performance of proposed approach was much better in comparison to the existing approaches.

A. Table of Comparison

Ref. No.	Year	Technique Used	Pros and Cons
15.	2017	An automatic DR detection approach was proposed for digital fundus images which was a dictionary learning (DL)-based approach.	Based on the conducted experiments and achieved outcomes it was seen that around 70% accuracy was achieved for normal images and 90% of accuracy was achieved for diabetic images when the proposed technique was tested on 30 color fundus images.
16.	2017	A novel approach was proposed using digital processing to detect the DR from retinal images at initial stage so that it can be controlled.	Through the experimental results it was seen that around 94% of predictive capacity and 95% of sensitivity were achieved as output. This research only focused on detecting hard exudates and did not detect soft exudates.
17.	2016	A hybrid approach was proposed to detect the Microaneurysms and Exudates from retinal fundus images in which the Fuzzy C-means clustering and morphological processing were combined.	The proposed method achieves 100% Sensitivity, 95.83% Specificity and 96.67% of Accuracy.
18.	2016	A comparative analysis of these different techniques was performed in this research for enhancing fundus images to be used for detecting diabetic retinopathy.	The end results showed a fair analysis of various parametric values for various techniques. It was observed that ESIHE had better entropy and SNR but had moderate AMBE and PSNR.
19.	2016	A novel approach was proposed that included various existing approaches which were of less quality and had an estimated locale for the macula position.	With the application of Gaussian channel along with morphological administrator, highly efficient results were achieved which had the least computational time. This research however, did not focus on improving the exactness of proposed work.
20.	2016	A novel approach was proposed for detecting and validating the microaneurysms and hemorrhages automatically from the color fundus images	It was seen that the performance of proposed approach was much better in comparison to the existing approaches. The bright lesion and new vessel were not detected by this proposed technique.

III. RESEARCH METHODLOGY

This research work is based on the diabetes retinopathy detection. The diabetes retinopathy detection has the various phases which are the image pre-processing, segmentation, feature extraction and classification. The phase of the proposed work is described below:-

1. Data Pre-Processing:- In this phase, the diabetes retinopathy image is taken for the detection. The input image in the RGB format which need to convert into the gray scale format. The gray scale image is further processed for the detection

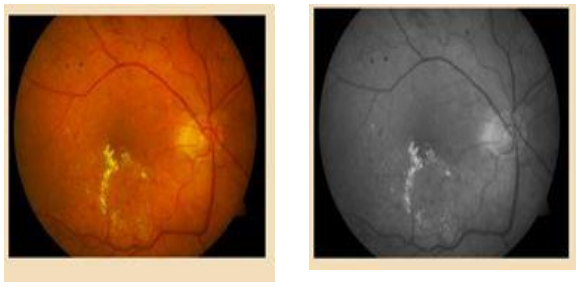

Figure 1: Data Pre-processing Phase (a) Input Image

(b) Gray scale Image

2. Optical Disk Segmentation:- The OD is seen as a bright yellowish or white area within the colored fundus images. For the optic disc, high and similar intensity values are available for exudates. Thus, the removal of optic disc from the retinal image is very important. The region properties and area identification are used for masking and removing this brighter optic disc. The optic disc and blood vessels are detected by applying edge detection algorithm after preprocessing. The counter detection is performed using canny edge detection algorithm. All the local maxima known as the gradient is preserved for improving the blurred edges by the canny edge detection algorithm.

2.1. Blood Vassal Extraction:- This is due to the fact that their concentration levels are similar. The high levels of contrasts vessels present in the blood are removed by applying dilation on the intensity image. Further, the dilation operation is used to fill the small holes present within the images along with the help of structuring element. There are different shapes in which structure elements (SE) exist. The optical disc and blood vessels are removed here using the flat disc shaped structure.

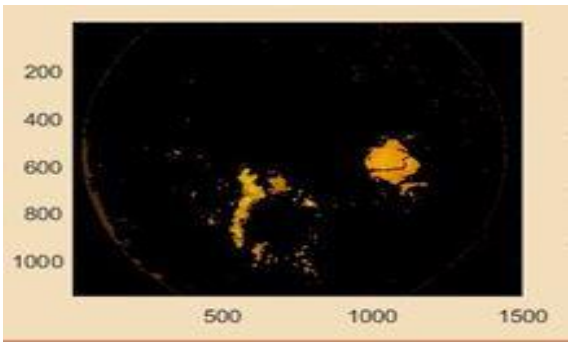

Figure 2: Optical Disk Segmentation

As shown in figure 2, the optical disk technique is applied which can segment the input image. The segmentation technique will segment the highlighted part of the image

3. Classification:- The last phase is of classification which is applied with the NN (Neural networks). The NN approach is the unsupervised approach for the diabetes retinopathy detection.

The training set is prepared based on the color features of the input image. The system can train itself until error gets minimized in the network. The stage at which error gets minimized at that stage system is considered as maximum trained. The test image is taken as input for the diabetes retinopathy detection. The test image will be matched with the training image and it generate final classified image which is shown in figure 3

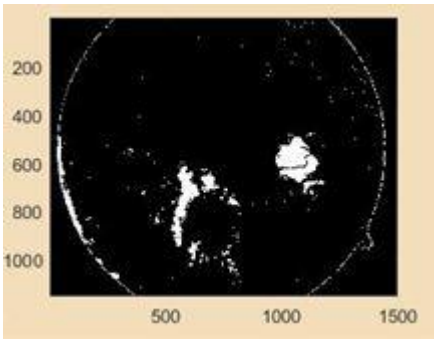

Figure 3: Classified image

As shown in figure 3, the final classified image shows which can classify the diabetes and non diabetes part of the eye. The white portion shows the diabetes portion of the image.

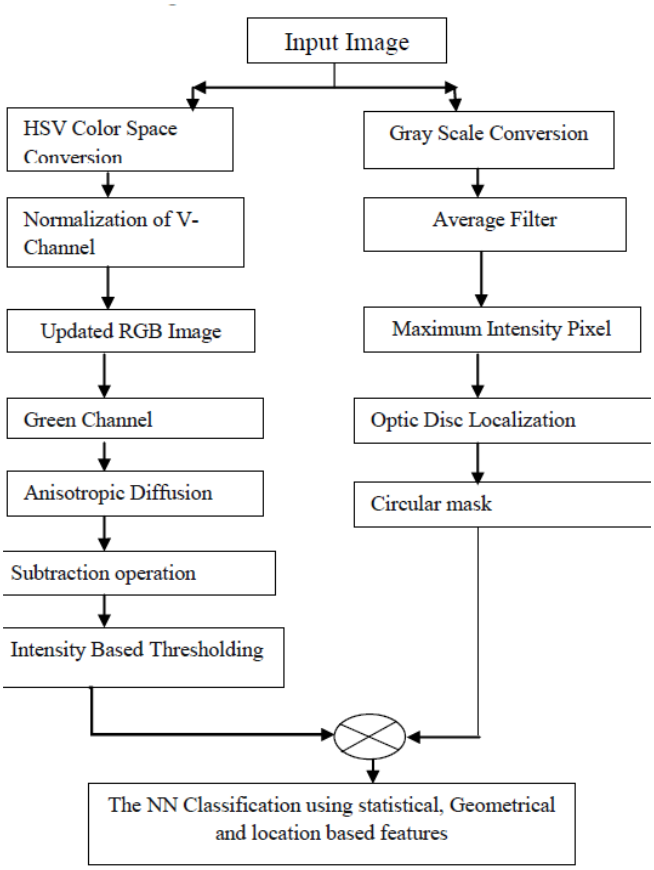

Figure 4: Proposed Flowchart

IV. EXPERIMENTAL RESULTS

The proposed algorithm use NN and optical disk segmentation for the classification of diabetes portion from the input image. The performance of the proposed model is analyzed in terms of accuracy, specificity and sensitivity on different set of image. The performance of proposed model is compared with existing SVM classification model. It is analyzed that NN give good results for the diabetes retinopathy detection

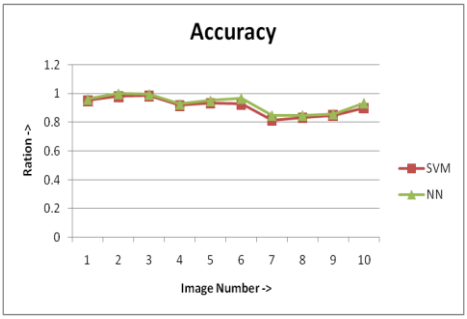

Figure 5: Accuracy Analysis

As shown in figure 5, the accuracy of the SVM classifier is compared with NN approach for diabetes retinopathy detection. The NN approach has high accuracy for the diabetes retinopathy detection ass compared to SVM classifier

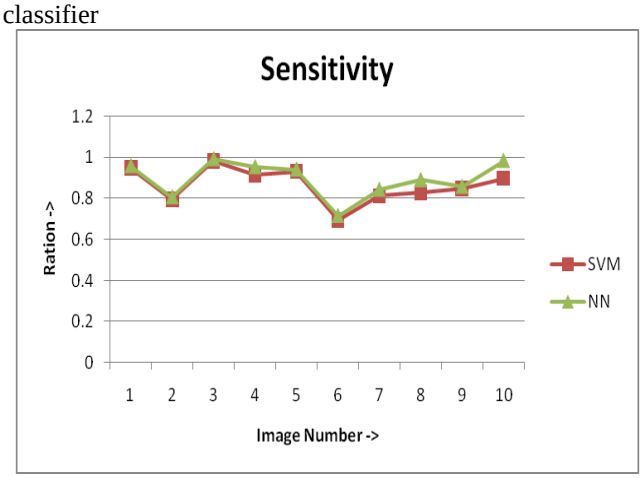

Figure 6: Sensitivity Analysis

As shown in figure 6, the sensitivity of the SVM classifier is compared with NN approach for diabetes retinopathy detection. The NN approach has high sensitivity for the diabetes retinopathy detection as compared to SVM classifier

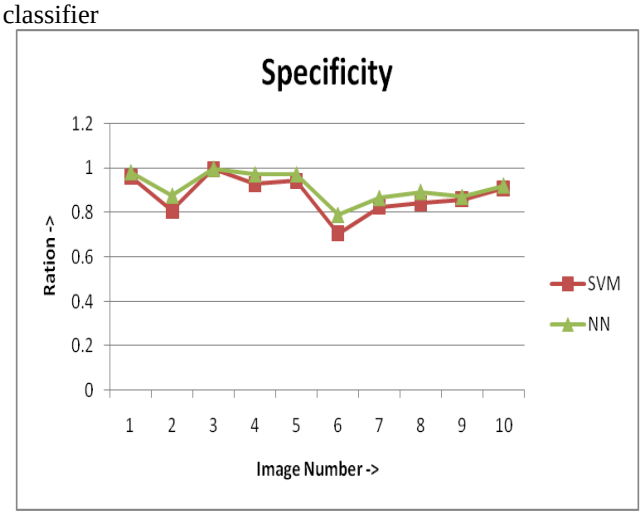

Figure 7: Specificity Analysis

As shown in figure 6, the specificity of the SVM classifier is compared with NN approach for diabetes retinopathy detection. The NN approach has high sensitivity for the diabetes retinopathy detection as compared to SVM classifier

V. CONCLUSION

In this paper, it is concluded that the retinal images are evaluated to diagnose the DR. It is however, time consuming and resource demanding to manually grade the images such that the severity of DR can be defined. When the tiny blood vessels present within the retina are damaged, only then can one notice this problem. Blood will flow from this tiny blood vessel and features are formed from the fluid that exists on retina. The diabetes retinopathy detection has the three phases which are pre-processing, feature extraction and classification. The NN classification approach is proposed in this research for the diabetes retinopathy detection. The proposed model is compared with the SVM classification model and it is analyzed that results are optimized up to 5 percent with the use of NN.

REFERENCES

1. Devvi Sarwinda, Alhadi Bustamam, Aniati M. Arymurthy, “Fundus Image Texture Features Analysis in Diabetic Retinopathy Diagnosis”, 2017 Eleventh International Conference on Sensing Technology (ICST)
2. Arisha Roy, Debasmita Dutta, Pratyusha Bhattacharya and Sabarna Choudhury, “Filter and Fuzzy C Means Based Feature Extraction and Classification of Diabetic Retinopathy using Support Vector Machines”, 2017, International Conference on Communication and Signal Processing
3. Ashish Issac, Malay Kishore Dutta, Carlos M. Travieso, “Automatic computer vision-based detection and quantitative analysis of indicative parameters for grading of diabetic retinopathy”, 2018, Neural Computing and Applications
4. Shailesh Kumar, Basant Kumar, “Diabetic Retinopathy Detection by Extracting Area and Number of Microaneurysm from Colour Fundus Image”, 2018 5th International Conference on Signal Processing and Integrated Networks (SPIN)
5. Carla Agurto, Victor Murray, Eduardo Barriga, Sergio Murillo, Marios Pattichis, Herbert Davis, Stephen Russell, Michael Abramoff, Peter Soliz, “Multiscale AM-FM Methods for Diabetic Retinopathy Lesion Detection”, IEEE Transactions on Medical Imaging, 2010, Volume: 29, Issue: 2, Pages: 502 - 512
6. Lei Zhang, Qin Li, Jane You, David Zhang, “A Modified Matched Filter With Double-Sided Thresholding for Screening Proliferative Diabetic Retinopathy”, IEEE Transactions on Information Technology in Biomedicine, 2009, Volume: 13, Issue: 4, Pages: 528 - 534
7. Sohini Roychowdhury, Dara D. Koozekanani, Keshab K. Parhi, “DREAM: Diabetic Retinopathy Analysis Using Machine Learning”, IEEE Journal of Biomedical and Health Informatics, 2014, Volume: 18, Issue: 5, Pages: 1717 - 1728
8. Gary G. Yen, Wen-Fung Leong, “A Sorting System for Hierarchical Grading of Diabetic Fundus Images: A Preliminary Study”, IEEE Transactions on Information Technology in Biomedicine, 2008, Volume: 12, Issue: 1, Pages: 118 - 130
9. Lama Seoud, Thomas Hurtut, Jihed Chelbi, Farida Cheriet, J. M. Pierre Langlois, “Red Lesion Detection Using Dynamic Shape Features for Diabetic Retinopathy Screening”, IEEE Transactions on Medical Imaging, 2016, Volume: 35, Issue: 4, Pages: 1116 - 1126
10. M.M. Fraza, S.A. Barmana, P. Remagninoa, A. Hoppea, A. Basitb, B. Uyyanonvarac, A.R. Rudnickad, C.G. Owend, “An Approach To Localize The Retinal Blood Vessels Using BitPlanes And Centerline Detection”, Comput. Methods Programs Biomed, 2011
11. Nikita Kashyap, Dr. Dharmendra Kumar Singh, “Color Histogram Based Image Retrieval Technique for Diabetic Retinopathy Detection”, 2017 2nd International Conference for Convergence in Technology (I2CT)
12. Toan Bui, Noppadol Maneerat, Ukrit Watchareeruetai, “Detection of Cotton Wool for Diabetic Retinopathy Analysis using Neural Network”, 2017 IEEE 10th International Workshop on Computational Intelligence and Applications
13. Somchok Kimpan, Noppadol Maneerat, “Diabetic Retinopathy Image Analysis Using Radial Inverse Force Histograms”, 2017, International Conference on Intelligent Informatics and Biomedical Sciences (ICIIBMS)
14. Z. A. Omar, M. Hanafi, S. Mashohor, N. F. M. Mahfudz, M. Muna’im, “Automatic Diabetic Retinopathy Detection and Classification System”, 2017 7th IEEE International Conference on System Engineering and Technology (ICSET 2017)
15. Narjes Karami, Hossein Rabbani, “A Dictionary Learning Based Method for Detection of Diabetic Retinopathy in Color Fundus Images”, 2017, 10th Iranian Conference on Machine Vision and Image Processing
16. Enrique V. Carrera, Andres Gonzalez, Ricardo Carrera, “Automated detection of diabetic retinopathy using SVM”, 2017 IEEE XXIV International Conference on Electronics, Electrical Engineering and Computing (INTERCON)

17. Harini R, Sheela N Rao, "Feature Extraction and Classification of Retinal Images for Automated Detection of Diabetic Retinopathy", 2016 Second International Conference on Cognitive Computing and Information Processing (CCIP)
18. Sharad Kumar Yadav, Shailesh Kumar, Basant Kumar, Rajiv Gupta, "Comparative Analysis of Fundus Image Enhancement in Detection of Diabetic Retinopathy", 2016 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)
19. V. Mohana Guru Sai Gupta, Surya Teja D., Sanchit Gupta and Prateek Sengar, "Extraction of Blood Veins from the Fundus Image to Detect Diabetic Retinopathy", 1st IEEE International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES-2016)
20. Lama Seoud, Thomas Hurtut, Jihed Chelbi, Farida Cheriet and J.M. Pierre Langlois, "Red Lesion Detection using Dynamic Shape Features for Diabetic Retinopathy Screening", 2016, IEEE Transactions on Medical Imaging, Volume: 35 , Issue: 4

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