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An efficient automatic detection and classification of soft/hard exudates using optimalartificial neural network

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Abstract:Diabetic retinopathy is a serious eye disease that can be considered a symptom of diabetes in the retina, as it has emerged as a common cause of blindness in the functional group. This is when the blood vessels in the retina change. Secretion is the main symptom of diabetes recurrence. If left untreated, diabetic retinopathy can cause irreversible damage to the optic nerve causing blindness. Therefore, early detection of diabetes is extremely important. In this article, we have suggested the appropriate procedure to obtain strong / soft bars on abnormal retinal images. The proposed system consists mainly of four modules, namely, (i) processing, (ii) acquisition of standard and non-standard images by fragmentation and fragmentation, (iii) classification of abnormal images and (iv) acquisition of soft and solid soils. . Initially, the transfer step was performed using a central filter to magnify the input retina image. After that, the image location of the retina is separated, that is, the optic disc, the blood vessel, and the location of the damage. Then, the GLCM features are extracted from each region. After the feature extraction, the extracted features are given to an optimal artificial neural network (OANN) to detect normal and abnormal images. In ANN, the weight values are optimally selected with the help of Cockroach Swarm Optimization Algorithm (CSO). After that, features of the segmented region are extracted. Then, the selected features are given to the ANN to classify the image as soft/hard exudates. The performance of our proposed method is evaluated in terms of accuracy, sensitivity, and specificity.

Keywords – Neural Network, ANN.

I. Introduction

Diabetes is one of the most widely recognized ailments in people. In excess of 360 million individuals experienced diabetes in 2012 overall [1]. The quantity of analyzed cases has developed quickly over the most recent couple of years and this propensity is assessed to proceed. Long haul diabetes additionally influences the eyes, bringing about an ailment called diabetic retinopathy (DR) [2].DR is a typical reason for vision debilitation in the total populace and the nearness of exudates on the retina has been found to affect vision misfortune [3]. Up to 80 % of all diabetics who have had diabetes for a long time or more are well on the way to be influenced by the infection. In the working-age individuals of the created nations, this is the most widely recognized reason for legitimate blindness [4].Regardless of these scary measurements, inquire about uncovers that if there were legitimate and convenient treatment and assessment of the eyes, at any rate 90% of these early cases could be limited [5]. DR regularly has no early admonition side effects. As fresh recruits vessels structure at the rear of the eye as a piece of proliferative diabetic retinopathy (PDR), they can drain (discharge) and obscure vision [6].

At first, it may not be extreme. As a rule, it will leave only a couple of bits of blood, or spots, drifting in an individual's visual field, however the spots frequently leave following a couple of hours. Inside a couple of days or weeks, these spots are frequently trailed by an a lot more noteworthy spillage of blood, which further hazy spots vision. In extraordinary cases, an individual might have the option to separate light from dim in that eye [7].It might take the blood anyplace from a couple of days to months or even a very long time to clear from within the eye, and now and again, the blood won't clear by any means. These kinds of enormous hemorrhages will in general happen more than once, frequently during rest [8]. DR finding requires identification of exudates on the retina which is performed by visual assessment of eye fundus images.Be that as it may, this is a tedious undertaking and the results are subject to the mastery of the analyst [9]. While completely programmed investigation of retinal pictures for exudate location is profoundly alluring, critical varieties fit as a fiddle, size and surface of the exudates make this a difficult undertaking [10]. The fundamental model of hard and delicate exudates location and characterization is given in figure 1.

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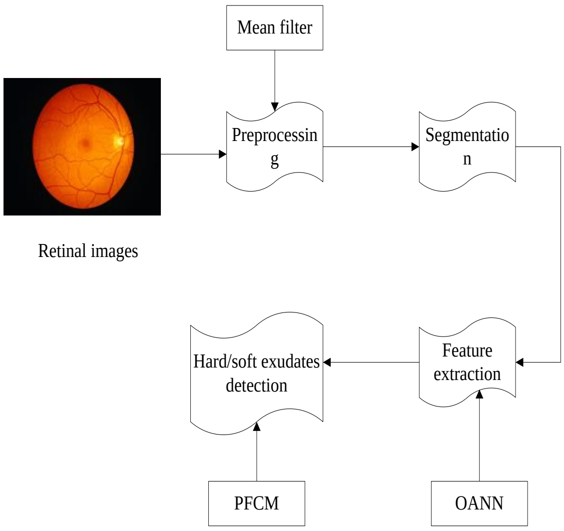

Figure 1: The basic model of hard and soft exudates

II. LITERATURE REVIEW

In this section, a review of Diabetic retinopathy detection and classification of soft/hard exudates is presented. Several types of research are available in existing techniques, to detect the hard/soft exudates in images. The detection of the hard/soft exudate from abnormal retinal images based on their different algorithms is analyzed. Here, we analyzed, several works related to detection based on their optimal techniques can be found. The surveyed papers are divided into five categories based on their optimization likely support vector machine, neural network, fuzzy logic classifier and other techniques related to detection and classification of hard and soft exudates.

A. Research articles related to SVM classifier

In this section, hard and soft exudates detection and classification using support vector machines are developed. A lot of researchers have developed a classification and detection using an SVM classifier. Among, those papers are given below,Long, S.,*et al*. [11] in 2019 has exhibited a programmed detection of hard exudates in shading retina pictures. Right now, support vector machine algorithm has been utilized to identify HE in retinal pictures. The proposed algorithm followed four techniques were preprocessing, confinement, assurance of patient HE and extraction HE area.

Amin, J., *et al*. [12] in 2018 analyzed a mechanized method that was applied for the detection and classification of DR by utilizing a SVM classifier. A nearby complexity improvement strategy was utilized on grayscale images to upgrade the locale of intrigue. A versatile limit strategy with scientific morphology was utilized for the precise sores locale division. From that point forward, the geometrical and measurable highlights were intertwined for better classification. The proposed technique was approved on DIARETDB1, E-ophtha, Messidor, and neighborhood informational collections with various measurements, for example, the region under the bend and accuracy. The test result shows that the accuracy of the strategy was 98.5%.

Waseem, S., *et al*. [13] in 2014 was dissected drusen exudate injury separation in shading fundus pictures. This strategy comprises of a two-organize system. The principal arrange after pre-preparing identifies every single brilliant pixel from the images. The suspicious pixels were expelled from the distinguished district. On the subsequent stage, splendid areas were named drusen and exudates through SVM. The proposed technique was assessed on publically accessible datasets STARE. The framework accomplishes 92% accuracy.

Ramasubramanian. B., *et al*. [14] in 2012 was developed the detection of exudates and diabetic fundus shading images. Right now, the image was divided utilizing the shading K-implies Clustering algorithm. The divided image alongside OD was picked. To classify this fragmented district, highlights dependent on shading and surface were separated. The selected highlight vector was then ordered into exudates and non-exudates using the SVM classifier. In addition, the detection of diabetic maculopathy, which was the peak stage of DR, was performed using the morphological procedure. Using a clinical standard, the excreta picture completeness rate was 96%. This technique seems promising as it can recognize the extremely little regions of exudates.

B. Research articles related to neural network

In this section, hard and soft exudates detection and classification using the neural network are analyzed. Many researchers have developed detection and classification of hard and soft exudates using neural networks. The existing development papers are given below,

Kavitha, M., et al. [15] In 2014 he made a series of clip acquisitions with a soft and solid image of the retina fundus. At this point, the first step was taken using the Gaussian channel to enlarge the educational retina images. As a result, common / uncommon acquisitions were discontinued using regional divisions; including the exclusion and segregation of neural networks based on Levenberg Marquardt. From an unusual retina image, they found soft / hard woods using a combination of c-media, a reflex background and a separate Levenberg-Marquardt network. In the presence of soft / solid exudates, medium size c was used to remove the damage. At that point, with the guide of the sectioned territory, highlights such as mean, variance, region, border, entropy, greatest force, least power, cross-correlation, autocorrelation and co-variance highlights were extracted. The outcomes have demonstrated that the technique has beated the current strategy by having prevalent accuracy of 90.91%.

Jayakumari, C., et al. [16] In 2008 an intelligent procedure was performed to obtain hard and soft DR exudates using a detoxification strategy using a repetitive neural network which was a neural condition that completes the effect compared to that of the combined comparisons under investigation. The secret neural network was organized using around 30 images containing 5 rare images

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and 25 rare images. The train system was tested with 5 standard and 20 unusual images and found to have satisfactory results with a sensitivity of 90% and an accuracy of 92%.

García, M., et al. [17] In 2009 an automatic diagnosis of one of these lesions, hard exudates, was developed to help ophthalmologists identify and monitor infection. They developed an algorithm that included neural network fragmentation. Three NN sensors were tested: multilayer perceptron, air base performance, and SVM. The database contained 117 images of different colors, brightness and quality. Fifty of them were used to prepare for NN separation and 67 (40 from DR patients and 27 from solid retinas) to test the strategy. The test result shows objective focus, 100% sensitivity, 92.59% specificity and 97.01% mean accuracy.

Hard exudates referral with the artificial neural network was created GoharNaqvi, S. A. *et al*. [18] in 2016. In the paper, a framework for referral of hard exudates was discussed. The framework has been shaped by combing different strategies like SIFT, K-means clustering, visual dictionaries and artificial neural networks. The performance of the framework was seen as better/comparable to the framework was 93.33% though the greatest specificity accomplished by 88.00%. The greatest region under the curve was seen as 90.67%.

Robotized identification and evaluating arrangement of DR utilizing profound neural networks was created by Zhang, W., *et al*. [19] in 2016. Currently, the convolutional neural network model and SIAME-like structure have been integrated into the learning process. In contrast to previous work, the model accepts fundus images as sources of information and reads their integrations to aid in prediction. In the case of a set of 28,104 image sets and a test set of 7,024 images, the area under the receiver duty curve was obtained through a proposed microscope model, which was 0.011 higher than the discrete model. The test result showed that the microscope model reached the elite with AUC 0.951 and sensitivity 82.2% with high performance and specificity of 70.7% with high sensitivity.

Jin, Q. et al. [20] In 2019, mechanical segregation models were analyzed for retinal detachment according to convolutional neural networks. Since normal convolutional neural networks require reinforcement with high dots, small retinal areas should be introduced for specific purposes. Occasionally the dots will introduce more sound. They train models from scratch and compare their discriminatory vessels / pixels with non-ship pixels in two data sets of retinal fundus images, DRIVE and STARE.

C. Research articles related to the fuzzy logic classifier

In this section, hard and soft exudates detection and classification using fuzzy logic classifier are analyzed. Many researchers analyzed the detection and classification of hard and soft exudates. Among, those research papers are given by,

Mansoor, A. B., et al. [21] in 2008 introduced a new algorithm based on fuzzy morphology for the computer-aided development of exudates in fundus imaging of the human retina to determine recurrence of diabetes. The disease has been tested for the presence of exudates in the macular area. Here, they use a diffuse morphology to enhance the exudates. The fundus image turned gray first, followed by subtle deterioration of the gemstone. Finally, the following image was added to the original image to transform it into an enhanced one. The study was carried out on a database of infected and external fundus images. The study produced convincing results, and images were improved in simple clinical trials.

Wisaeng, K., *et al*. [22] in 2012 Displays automatic detection of secretions in DR images. Retina color images were segmented using FCM clustering and morphological strategies and major pre-processing steps were followed, such as color uniformity, contrast improvement, dislocation, and color space selection. This empowers its difference in their strategies compared to other approach and the algorithm can achieve great performance even on low-quality retinal pictures. The outcome shows that accuracy esteems increase up to 92.5% when the FCM clustering was combined with morphological strategies techniques.

Ranamuka, N.G., et al. [23] In 2013, severe secretions were detected from normal pictures of diabetic patients using morphological imaging and fuzzy logic to detect solid secretions from a doctor's retinal imaging. In the lower stage, the exudate is accepted through mathematical morphogenesis, including removal of the optic lamina. In this sense, the complex secretions are extracted by a flexible logic algorithm that uses the values in the RGB color space of the grid image to free the hidden frames and write the functions. The total pixel output for all dark pixels is calculated using the available detail for the red, green, and blue flow channels. This uneven production has led to the success of hard work as growth in the heavy exudate area. When comparing the results with facts from the world drawn by hand, the creators found sensitivity and precision of up to 75.43 and 99.99%, respectively, and the precision was 99.87%.

Afrin, R., et al. [24] in 2019, a robust structure that detects retinal lesions (arteries, microaneurysms, and exudates) in retinal thinking was evaluated and automatically isolated into DR categories. Blood vessels, microaneurysms, and exudates were detected early using cognitive techniques. The vein field, microaneurysm count, exudate region, contrast, and homogeneity are evident in image images such as retinal tone. This prominence is ultimately maintained in a complex structure based on NPDR classification of NPDR standard, mild, moderate, potent NPDR and PDR. A total of 400 collected images were collected from the STARE, DIARETDB0 and DIARETDB1 database and the images were successfully classified using a 95.63% problem solver.

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Yildirim, B., *et al*. [25] in 2019 was created division of retinal veins utilizing a novel fuzzy logic algorithm. This technique can be utilized in computer examinations of retinal images, e.g., in mechanized screening for diabetic retinopathy. The technique was tried on the publicly accessible database DRIVE and its outcomes are compared with recognized distributed strategies. Technique achieved a normal accuracy of 93.82% and a territory under the receiver working characteristic curve of 94.19% for the DRIVE database. The outcomes exhibited a normal sensitivity of 72.28% and a specificity of 97.04%.

Sopharak, K., et al. [26] In 2009, high-quality abbreviations of patient images who were able to integrate FCM were examined. Comparisons prior to four exposures, specific strengths, standard power variations, hues and edges of different pixels, extracted to be provided as information parameters for large variations using the FCM integration process, were used. The main effect was then applied to behavioral strategies. The results of the acquisition are verified by comparing international handmade certificates. It was found that the proposed process found sympathetic, specific, PPV, PLR winners with an accuracy of 87.28%, 99.24%, 42.77%, 224.26 and 99.11%, respectively.

D. Research articles related to other techniques

In this section, soft and hard exudates detection and classification using other techniques are analyzed. Many researchers are developed the hard and soft exudates detection and classification. Among, those existing papers are given by,

Vasant, S., *et al*. [27] in 2014 developed an advanced technique for automatic exudates detection in retinal images using linear background removal. They use the threshold for mathematical morphology and exudates detection. One test result shows 99.88% accuracy of the images.

Somasundaram, A., et al. [28] In 2013, a robotic algorithm was shown to detect and detect the presence of exudates from low-resolution images of patients who were rehabilitated and by extended surrogate studies were evaluated. At this point, the fundus image of the retina was first examined. At that time, the masking process and the scoring process were used to differentiate the formation of retinal fundus images. This method does not require management awareness which requires a fictional name, which can create human error and become a tedious process. You can clearly see the sores because the aliens were clearly visible in the optic circle and veins. It allows ophthalmologists to use appropriate medications that can eliminate the disease or reduce its severity. Test results show that the accuracy of the paper was 94.5%.

Automatic detection of hard and soft exudates in fundus images using solid color histogram presented by Kavitha, S., et al. [29] in 2011. Advances in the analysis of the classification of hard and soft exudates were made using thinking methods. Initially, the color images of the fundus and retina were intended to promote color-correction of the ICD and the fundus area by performing binarization and mathematical morphology, respectively. Exudates were obtained with a color histogram guide, which was used to distinguish the hard and soft pixel in the color image of the retina fundus. The publicly available diagnostic data of DIARETDB1 indicates improved performance of the proposed exudate autodetection procedure. These independent figures are allowed compared to those drawn by hand by an optometrist. Sensitivity, specificity, and accuracy were used to assess high penetration.

Sopharak, A., et al. [30] in 2011 automatic detection of microaneurysms from untreated images of the RD retina using mathematical morphology techniques. This article examines the various behavioral limitations used for the detection of microaneurysms in immature students with low-level retinal imaging. The detected microaneurysms are allowed compared to the fact published by ophthalmologists.

E. Summary of the survey

Detection and classification of hard and soft exudates are challenging tasks. Therefore, it is a major research topic in the medical field. In the above survey, we analyzed the concept of hard and soft exudates of classification published in the literature between 2008-2019 December. We select the literature from scientific journals such as IEEE, Elsevier, Springer and other international journals. In this survey, we have selected a total of twenty papers and each method's advantages and disadvantages are analyzed. Therefore, there is an opportunity to pursue and improve previously comprehensive research articles in the field of detection and classification of soft and hard exudates. Some of the research gaps are,

- Some research articles have only extracted minimal features to perform classification and therefore reduce accuracy.
- These techniques are inadequate to use detailed information of the eye and are not possible for the entire database.
- Some research articles have not used the dimensionality reduction method, which may increase the system problem.
- In such articles contains computational complexity.

To enhance the hard and soft exudates detection and classification, the segmentation method has been developed.

III. ANALYSIS AND DISCUSSION

In this section, the analysis and discussion of all the articles taken for the above survey are planned. In this analysis, the individuality of existing works is analyzed. Analysis based on four different types of implementation tools, dataset, and performance analysis and achieved results.

A. Analysis based on the implementation tools

In figure 2, implementation tools used in the literature is analyzed. As per the literature review, MATLAB software is

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used for most of the existing methods. The remaining paper contains JAVA and Python software tools. In this research paper, JAVA software is used only one paper (i.e.) [11] and the Python software is used two papers [18] [25].

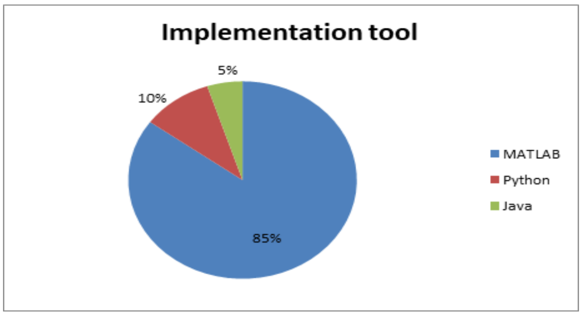

Figure 2: Analysis based implementation tool

B. Analysis based on the dataset

In this section, the dataset used to detect and classification of hard and software exudates is analyzed. Figure 3, shows the analysis based on the dataset is utilized. In the literature, a total of twenty papers are analyzed which is collected from local hospitals, DIARETDB1, STARE, DRIVE, MIT/BIH and Eophtha. Besides research papers [1, 2. 10, 19, 13, 14, 19] are used DIARETDB1, and research papers [3, 12] are utilized STARE dataset, the existing papers [15, 16, 7, 6] are utilized DRIVE datasets, and research articles related to [11, 18] are used to MIT/BIH, and the existing papers [5, 8, 20] was utilized Eophta and the remaining data's are utilized to local dataset. From the analysis, real-time data are most important.

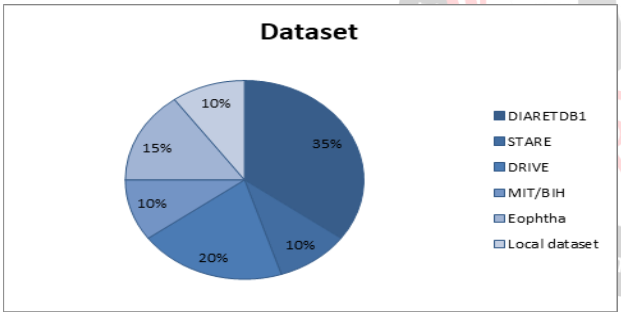

Figure 3: Analysis based dataset

C. Analysis based on the performance analysis

In this section, the analysis of key performance measures is analyzed. Each sheet contains different performance analyzes such as sensitivity, specificity, and accuracy. For the classification process, sensitivity, specificity and accuracy are measured. Performance measures are analyzed and Table 1 is presented below.

Table 1: Performance measures

Performance measure	Literature review
Accuracy	[1, 2, 3, 5, 6, 7, 10, 12, 13, 14, 16, 17, 18, 19, 20]
Sensitivity	[1, 6, 7, 15, 16, 19, 20]
Specificity	[1, 7, 8, 9, 13, 15, 16, 19, 20]
Success rate	[4, 11]

D. Analysis based on feature extraction

Feature extraction is an important stage of classification. Analysis based on the feature extraction method is given in figure 4. When analyzing figure 4, 72% of papers are utilized GLCM based features. 15% of papers are utilized texture features, 5% of papers utilized DWT based features and reaming papers are utilized other features. Most of the researchers are utilized GLCM features. Because, the GLCM feature is contains all types of texture features.

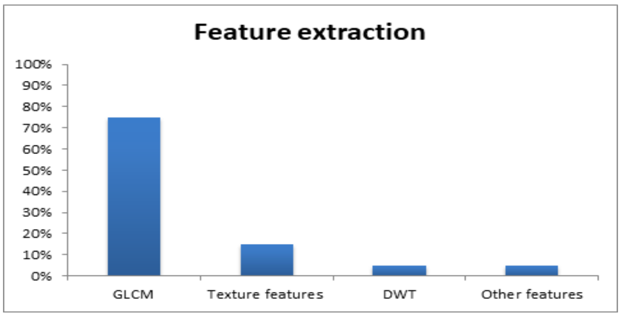

Figure 4: Analysis based feature extraction

IV. CONCLUSION

A total of thirty papers were analyzed in this survey, which was from different years and from different journals. This survey provided a critical review of a method based on the classification of hard and soft exudates. The study has four different classifications, namely, neural network-related research articles, support vector machine-related research articles, fuzzy logic classification research articles, and other optimization techniques. Review documents are analyzed based on four factors: feature extraction techniques, dataset, implementation tools and performance measures. Besides, some research gaps in the existing works are analyzed. Therefore, it is necessary to improve the accuracy of the classification system. Finally, some research issues have been elaborated to encourage further research in similar directions.

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