An Evolutionary Particle Swarm Optimization based Classification Technique for Detection of Diabetic Retinopathy

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Abstract- The evaluation of retinal images is carried out for the diagnosis of diabetic retinopathy. This is a tedious process and requires manned grading of images for describing the risk level of this disease. This disease can ruin the small retinal blood vessels. The blood flows from these vessels and attributes are generated from the fluid of retina. The attributes regarding the outflow of fluid and blood from play an important role in the diagnosis of this malady. In the existing method of diabetes retinopathy detection the image is pre-processing, the feature of the pre-processed processed image is extracted with the help of particle swarm optimization method. The technique of optical disk segmentation is applied for the segmentation of diabetes portion. The existing method is extended in this research work using KNN classification. The implementation of proposed is carried out in MATLAB tool. The analysis of achieved outcomes is carried out in terms of different performance metrics. As per the analysis, the new algorithm shows better performance than the earlier algorithm.

Keywords- Diabetic, KNN, Segmentation, Optical Disk, PSO, micro aneurysms

I. INTRODUCTION

The image retrievals from the required database can be assisted with the help of similar images due to which they are considered as being important [1]. However, the presence of noises in the background results in degrading the original or captured images. Either when the images are being captured or are being communicated, noises can enter their backgrounds. For studying the physical appearances of humans on the basis of the electromagnetic radiation properties, the perception of human face color can be studied. Among the client and the server, transmission of images and their content is possible [2]. The information is stored in this technology in graphical form. The processing parameter is used to represent each node on the graph [3]. For generating hard copies of data such as the printout or Photostat, the analog techniques are used in image processing technology. For interpretation of the relevant data the visual techniques are applied by the user since huge amount of data is included in them. There is no particular field to which the image processing technique is limited. Any of the applications can use this technique for helping process the important content existing in the images.

Diabetic Retinopathy (DR) is an eye disease. Diabetes mellitus is the main reason of this disease. The complications of DM (Diabetes Mellitus) cause harm to the eye retina in this disease. The improper treatment of this can result in vision loss [4]. Generally, the sightlessness in the early stage of DR disease can be prevented with regular checkups and efficient control of basic diabetes. DR disease damages the retinal blood vessels due to the diabetes. In United States of America, this disease is considered as the main cause of vision loss. Some signs of this disease are indistinct vision, obscurity in seeing colors, floaters, and even total blindness. It is imperative for diabetic people to check their vision at least once in a year to prevent diabetic retinopathy. Nowadays, the signs of this disease can be relieved by retinal surgeries. However, the most efficient method to rule out this disease is to control diabetes and manage its early signs. it is very important to provide regular screening of retina of the diabetic patients. It becomes easy for an eye care specialist to have a clear view of the retina of diabetic patients with the help of automatic or computer-aided analysis [5]. On the fundus images, the quantification of diabetic retinopathy and identification of features has been done. However, no reliable or robust techniques have been proposed by researchers till now even though few particular features of retina can be analyzed by them.

Applied classifiers:

1.1 KNN classifier: Depending upon the Euclidean distance that exists between a test sample and the particular training samples [8], the value of k-nearest neighbor classifier is calculated. Below equation defines the Euclidean distance that exists between sample xi and xl(l=1,2,…,n) as:

$$d(x_i, x_i) = \sqrt{(x_{i1} - x_{i1})^2 + (x_{i2} - x_{i2})^2 + \cdots + \left(x_{ip} - x_{ip}\right)^2} \quad \ldots(2)$$

$$A\,Ri = \left\{x \in R_p : d(x, x_i) \leq d(x, xm), \forall i \neq m\right\} \quad \ldots(3)$$

All the neighboring points that are closest to every sample are encapsulated by the Voronoi cell. The above equation defines this Voronoi cell which is represented as Ri for sample xi. All the points that possibly exist in the Voronoi cell Ri are represented by x [9] [10].

II. LITERATURE REVIEW

Narjes Karami, et al. (2017) recommended a novel algorithm based on DL (Dictionary Learning) for automatically detecting DR [11]. In order to detect this disease, this work made use of digital fundus images. These images were represented in the optimal atomic manner for detecting DR. The detection approach was based on the learned dictionaries by K-SVD algorithm. These dictionaries could distinguish the healthy and diabetic objects. Therefore, in every class, the optimal differentiating atoms were achieved for representing images in minute way. The classification rule was dependent on the optimal sparse demonstration. This implied that the test image was related to the class with minimal amount of particular optimal atoms. This work made use of 30 color fundus images for the testing of recommended approach. This approach achieved accuracy rate of 70% for normal images and 90% for diabetic images.

Enrique V. Carrera, et al. (2017) recommended a computer based diagnosis for earlier detection of DR. This system processed fundus images of retina digitally for disease diagnosis. Classifying the grade of non-proliferative DR in automatic manner on the image of retina was the main aim of this system [12]. It was concluded that implementation of image processing on retinal images could generate satisfactory results in DR detection. The recommended approach provided good results for diagnosing DR. The future work would be focused on evaluating this approach clinically for integrating the existing approaches in a technology for DR detection.

Harini R, et al. (2016) made use of Fuzzy C-Means (FCM) clustering and morphological IP (image processing) for detecting diabetic retinopathy [13]. Image pre-processing was carried out using different techniques. These techniques included image resizing, CLAHE, contrast regulation, gray and green channel withdrawal from the color fundus images. In this work, support vector machine classification model was implemented for the classification purpose. This classifier used some particular features. This classifier efficiently classified DR images with high accuracy, sensitivity and specificity of 96.67%, 100%, and 95.83% respectively.

Toan Bui, et al. (2017) proposed an automatic segmentation approach through which the cotton wool spots which exist within the retinal images are detected such that DR disease can be recognized [14]. For preventing any further losses such as blindness or vision loss, it is important to detect cotton wool previously. The image quality's enhancement which is followed by the removal of optic disc is done through preprocessing. For improving the level of accuracy of classification stage, useful elements are taken with the help of feature extraction method. In order to perform learning and conducting tests by k-fold cross validation, a neural network approach is proposed here. On the DIARETDB1 public data, the evaluation of proposed approach is done in real time. It is seen that in terms of sensitivity, specificity as well as accuracy, the performance of proposed approach is better.

Somchok Kimpan, et al. (2017) proposed a novel approach in which the image properties were extracted by applying image retrieval system in which the theory of gravitation of Newton was applied [15]. The force that exists between pixels that are present in every pixel image is calculated here by using the center of gravity that has similar radius. For extracting a unique feature from the image, RIFH is applied and the results achieved are better. In order to help doctors diagnose the DR treatment decisions, the image retrieval is enhanced by providing more details of retinal DR images. The DR images can be detected and retrieved from the database as per the experimental results. Thus, the retinal disorders can be diagnosed very effectively with the help of this approach.

Sharad Kumar Yadav, et al. (2016) presented a study in which the different fundus image enhancement techniques applied for detecting DR were analyzed and compared. Presence of noise, poor contrast and non-uniform illumination are some of the common deficiencies available within medical images. Therefore, it is important to perform pre-processing of these images initially [16]. On the basis of spatial domain, several techniques are proposed that enhance the quality of images. However, appropriate results are generated for non-uniform illumination and varieties of low-contract through the declining of these methods. The most appropriate approach is selected with the help of comparative analysis and evaluation of different enhancement techniques. Thus, the detection of DR is improved to greater extent here. During the detection of DR, the pre-processing of fundus image is done for which comparison of different techniques such as CLACHE, HE, ADHE and ESIHE is done. MATLAB simulator is used to perform simulations on proposed technique such that its performance can be evaluated. In terms of different parametric values a fair analysis of different techniques is achieved at the end.

III. RESEARCH METHODOLOGY

3.1 Optical disc elimination: One of the most important tasks in the retinal fundus images is to detect and remove the OD (Optic Disk). This task is considered significant due to its resemblance with the exudates in terms of intensity, color and contrast. Optic disk makes its appearance always in the outcomes of exudate detection. Therefore, its removal is necessary. In addition, OD (Optic Disk) is a vital feature of eye retina. This feature could be employed for the validation of retinal pictures. It is also possible to use this feature for the diagnosis of other maladies such as Glaucoma. In general, this feature can be masked or removed using by identifying the region of interest and its features. Once the pre-processing is performed, the edge detection algorithm is applied for the detection of OD and the blood vessels. One of a popular edge detection algorithm is known as canny edge detection algorithm. This algorithm is used to detect the counter. This algorithm maintains the every local maxima called gradient to improve the indistinct boundaries. Hence, this algorithm detects the edge attributes in optimum manner. In order to generate the mask picture, this process makes use of logical black and white function. This function creates and inverts the image. Then, this process removes the created mask image from the boundary identified image.

3.2. Blood vessels extraction and removal: Some retinal features such as micro aneurysms and exudates can be detected by removing blood vessels and OD from the images of retina. The concentration level of features is quite similar. The dilation process can be applied on the intensity image for removing the high levels vessels. Structure elements (SE) can be of different shapes. This work makes use of flat disc shaped formation for the removal of OD and blood vessels.

3.3. Detection of exudates and micro-aneurysms: The detection of exudates features is carried out after the removal of blood vessels and OD from the retina image. Exudates can be described as the bright lesions of retinal image. These types of features can be detected by applying morphological closing operation. This closing operation is implemented on the eroded fundus image [12].

3.4. Apply PSO algorithm:- The present iteration and earlier iterations are compared on the basis of swarm value. The objective function is identified using the swarm value having maximum iteration. The following expression describes the dynamic objective function. Execution of every iteration changes the value.

$$v_{i+1} = v_i + c * rand * (p_{best} - x_i) + c * rand * (g_{best} - x_i)$$

In the above equation, V_i represents the element velocity. The variable p_{best} represents the optimum value among accessible options. The variable "rand.x" represents random number. This is the value given to every feature of the website. The "c" variable defines this value. This procedure selects the optimum value recognized from overall population and demonstrates it as p_{best}. The best value selected after each iteration is represented by "g_{best}". The obtained value is added with the traverse value of every attribute for concluding the objective function. This phenomenon is given as:

$$x_{i+1} = x_i + v_{i+1}$$

The "$x_{(i+1)}$" denotes position vector. These multi-objective optimization issues are solved by using dynamic PSO algorithms regarding the best computed value. The PSO algorithm gives the data utilized for encryption as input.

The key utilized for encoding provides support to generate enhanced value. It is possible to resolve issues related to both classification as well as regression using KNN classifier. But, the use of this classifier is quite common in solving the industrial classification issues. To evaluate any technique we generally look at 3 important aspects:

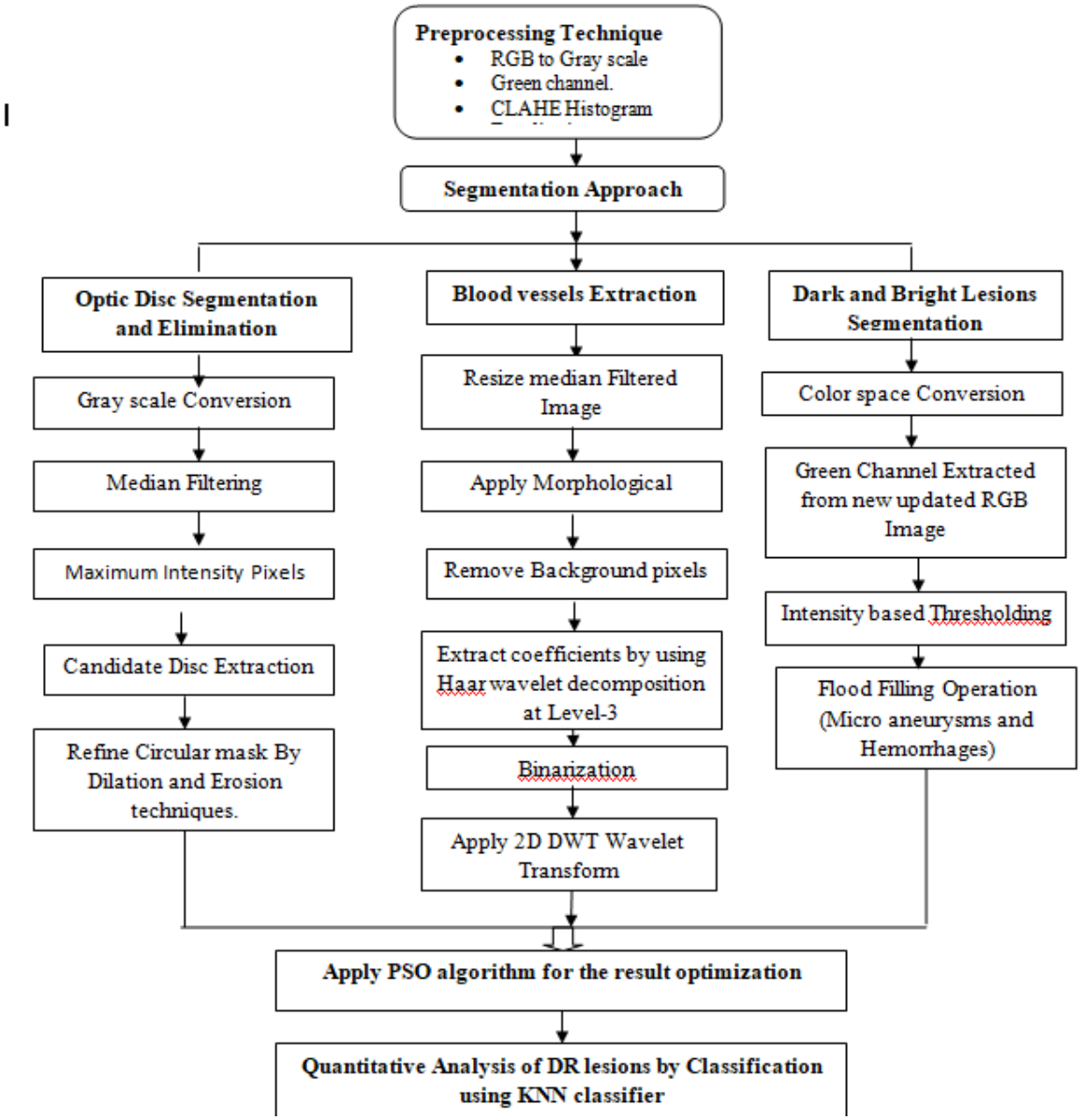

Figure 1: Proposed Flowchart

IV. GRADING THE DIABETIC RETINOPATHY DISEASE AFTER CLASSIFICATION

1) Normal (if no micro aneurysms, exudates and hemorrhages are detected than image is classified as normal) No any dot appears in normal case.

2) Non-proliferative diabetic retinopathy (if bright lesion, exudates are detected than disease classified as NPDR) Dot size is medium and range between 5 and 10.
3) Proliferative diabetic retinopathy(if micro aneurysms, hemorrhages are detected than disease classified as PDR, this is advance stage where deep dot size large and range above 10)

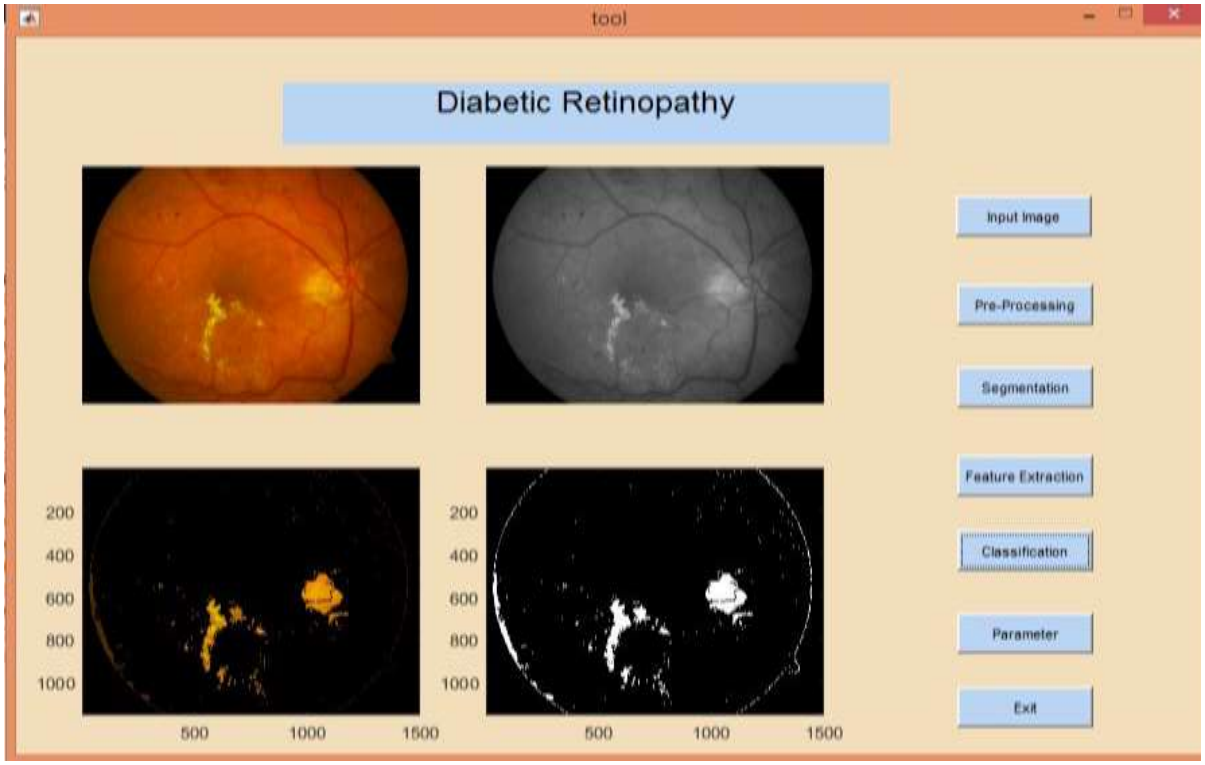

Figure 2: classification

As shown in figure the fourth phase of the implementation the PSO and Classification. The image is taken as input which is converted to grayscale. The grayscale image is segmented using the optical disk segmentation technique. In the last phase, the PSO used for feature extraction and KNN classifier is applied which will classify diabetes portion.

V. RESULT AND DISCUSSION

Mathematical software that is used in industry as well as academia for performing various simulations is called MATRIX LABORATORY or MATLAB. For almost all the applications of science and engineering, MATLAB acts as an interactive program as it provides numerical computation and data visualization and has programming capabilities which make it a very useful tool. Symbolic manipulations cannot be performed on MATLAB without using any additional Toolboxes which was possible earlier in other mathematical packages. However, for numerical calculations, this tool is used very popularly

Performance measures obtained using proposed method:

Database: Messidor

Table No.1 Comparison

Approach	Previous	Current
Sensitivity	86.03%	92.57%
Specificity	79.69%	87.57%
Accuracy	84.00%	95%

Figure 2 shows the performance analysis of recommended and earlier algorithm in terms of accuracy using different types of retinal pictures. As per the achieved outcomes, the recommended algorithm shows more accuracy than the earlier algorithm.

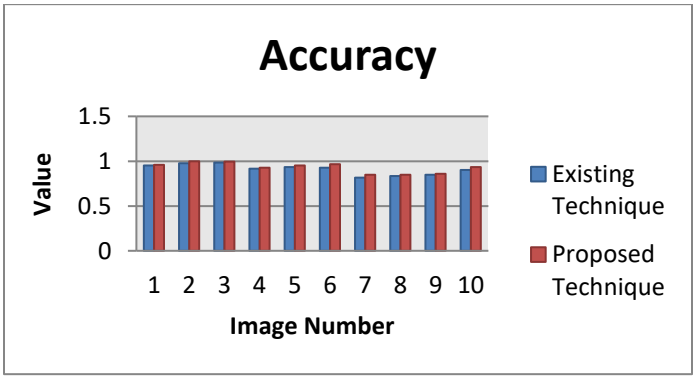

Figure 2 Accuracy Analysis

Figure 3 shows the performance analysis of recommended and earlier algorithm in terms of sensitivity using different types of retinal pictures. As per the achieved outcomes, the recommended algorithm shows more sensitivity than the earlier algorithm.

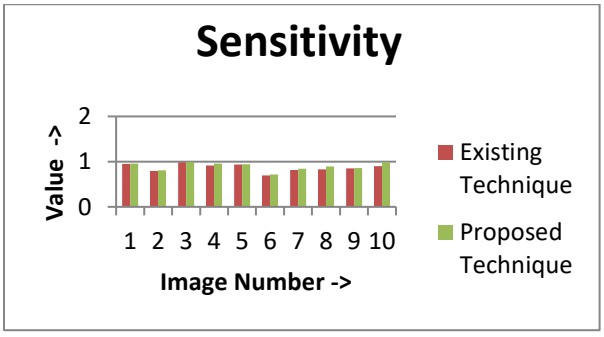

Figure 3 Sensitivity Analysis

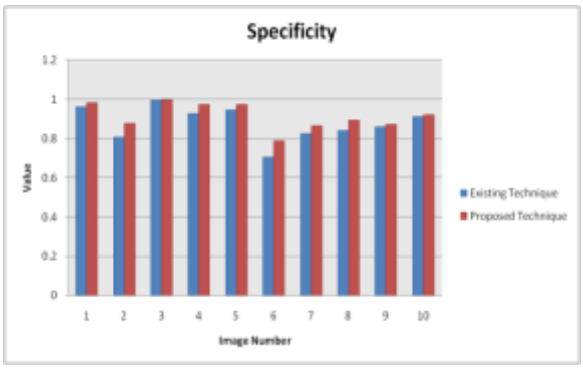

Figure 4 Specificity Analysis

Figure 4 shows the performance analysis of recommended and earlier algorithm in terms of specificity using different types of retinal pictures. As per the achieved outcomes, the recommended algorithm shows more specificity than the earlier algorithm.

VI. CONCLUSION

Diabetic Retinopathy (DR) is an eye disease. Diabetes mellitus is the main reason of this disease. The complications of DM (Diabetes Mellitus) cause harm to the eye retina in this disease. In United States of America, this disease is considered as the main cause of vision loss. Some signs of this disease are indistinct vision, obscurity in seeing colors, floaters, and even total blindness. It is imperative for diabetic people to check their vision at least once in a year to prevent diabetic retinopathy. With the time, a lot of approaches have been presented to diagnose this disease in early stage. In general, the evaluation of retina images is carried out for diagnosing this disease. But, this is a tedious process and requires manned grading of images for describing the risk level of this disease. This disease can ruin the small retinal blood vessels. The blood flows from these vessels and attributes are generated from the fluid of retina. There are mainly three stages included in the detection of DR disease. These stages are called pre-processing, feature extraction and classification. This work implements KNN classifier for classifying diabetic regions from the retinal images. The new approach shows better performance than earlier approach in terms of different performance metrics for DR detection.

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