Reduction of False Microaneurysms in Retinal Fundus Images using Fuzzy C-Means Clustering in terms NLM Anisotropic Filter

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ABSTRACT
The identification of MAs is an important phase in the research and grading of suffering from diabetes retinopathy. We present clustering strategy to identify the microaneurysms from the optic disk and cup in the retinal fundus pictures. Fuzzy C-Means (FCM) Clustering is used for clustering the information in which the information factors are grouped with different account level. The first and major phase is preprocessing function, in which the optic cup and disk of the feedback picture is being turned. Originally the optic hard disk is turned in some position and the range between the information factors is calculated and a group is established in accordance with the centroid. For retrieving micro aneurysms in all retinal images in our previous work we used SVM Classification filter in Fuzzy C-Means Clustering. In this paper we propose an effective filtering technique for micro aneurysms detection in retinal image preprocessing. Instead of SVM Filtering technique we used NLM in terms of Anisotropic Filter to process retinal images. Tested on the various simulated retina data repositories combining rotation and scaling, the developed method presents good results and shows robustness to rotations and scale changes.

Index Terms
Fuzzy C Means Clustering, Spatial Information, Fundus Image, Biomedical image processing, image classification, pattern recognition, medical decision-making, Non-Local Methodologies, Anisotropic Diffusion Filter.

1. INTRODUCTION
The therapy of suffering from diabetes macular Edema(DME) has evolved over time with medical and medical treatments increasingly being regarded and applied, moreover to traditional retinal laser device photocoagulation. Diabetic retinopathy (DR) is one of the problems of diabetes that produces in most of the sufferers with longstanding illness, and the top cause of loss of sight in the developed countries. Efficient therapies for DR are available, though it needs beginning analysis and the continuous monitoring of diabetics. Appropriate DR is conducted by the evaluation of retinal (fundus) pictures. Guide rating of these images to figure out the degree of DR is rather slowly and resource demanding [1]. The existence of micro aneurysms (MAs) on the retina is the first and most attribute indication of this illness. the problem of computerized retinal MA identification, and recommend a means for this procedure, which became extremely aggressive with most of the state-of-the-art ones, based on the outcomes of an start online competitors. The identification of MAs is important in the procedure of DR rating, since it types the reasons for determining whether an picture of a patient's eye should be regarded healthier or not. Therefore, it is not amazing that the literary works on the factors of creating a computer aided diagnosis (CAD) system for the identification of DR and other eye relevant illnesses is rather comprehensive, and the research of retinal pictures is a very promising area for the electronic picture handling community.

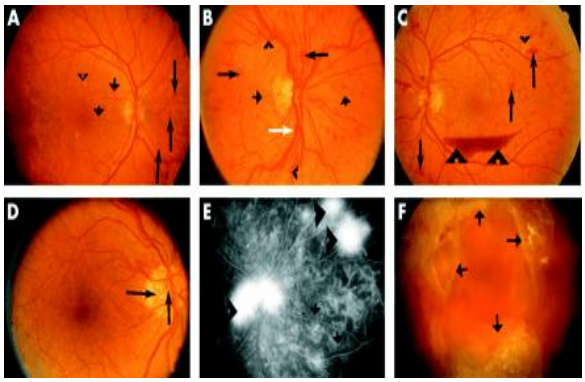

Figure 1: Colour fundus photography (CFP) and fluorescein fundus angiography (FFA) showing different features of diabetic retinopathy (DR). (A) An eye with mild non-proliferative diabetic retinopathy (NPDR) presented with microaneurysms (short arrows), hemorrhages (long arrows), as well as hard and soft exudates (arrowhead). (B) An eye with severe NPDR showing a greater number of microaneurysms (short arrows), hemorrhages (long arrows), and also venous abnormalities such as venous dilatation (white arrow) and tortuosity (arrowheads). (C) and (D) Eyes with high risk proliferative diabetic retinopathy (PDR). (E) and (F) are the semantic pixel value retrieval in retinal images with includes efficient and effective data processing in pixel notations.

MAs have a medically recognized maximum size, usually considered to be less than the size of the significant optic blood stream vessels [2]. Crossings of slim blood stream vessels may result in little round spots that are regionally just like MAs, both in style. Vessel segments may be turned off from the general shrub, and appear as little, black things of various forms. Almost every state-of-the-art technique views some type of image preprocessing phase, which usually includes disturbance decrease, filtering or colour modification. Retinal pictures have the largest comparison in the natural channel; accordingly it is a common practice to use

the natural route for segmentation reasons. For noise decrease, convolution with Gaussian covers and median filtering are commonly used techniques. The number of pixels to be prepared is considerably decreased by only considering the local maxima of the preprocessed picture. We implement optimum recognition on each information, and determine a set of principles that explain the size, size, and form of the main optimum. The fundus picture features are produced with the success as 99, 94 and 100% for hard drive localization, hard drive border recognition and fovea localization re-spectively. These designs can be enhanced in bigger databases and also used for medical reasons. The area growing segmentation technique gives the good segmentation result in order to specify the area with appropriate factors. It takes too lots of your energy and effort to complete the clustering process, so it is expensive. The region splitting and consolidating technique will divided the pictures until the appropriate quality is achieved in [3] . It is not suitable for more variety of pictures prepared simultaneously. Watershed is the edge based picture segmentation technique provides a huge variety of segmented pictures with high reliability which also experiences in over segmentation. Unclear C indicates (FCM) is a details clustering technique in which a details set is arranged into 'n' groups with every details point in the dataset which belongs to every group to a certain degree.

A conventional FCM criteria does not incorporate the spatial details which makes it delicate to disturbance and other picture relics whereas Spatial Unclear C means clustering criteria features the spatial information into the account function for clustering. The Customized Spatial Unclear C-Means clustering method is used to identify glaucoma which is existing in the retina with various spatial harmonizes. To optimize the detection procedure of microaneurysms, instead of using FCM Clustering with SVM based classification filter, we use NLM (Non-Local Methods) in terms of Anisotropic Filter for reduction of microaneurysms in uploaded retinal images. The fuzzy c means clustering strategy is applied to input image then cluster groups will formed then NLM anisotropic diffusion strategy is applied to detect the microaneurysms and finally the candidates can be extracted using connected components technique. From the analysis we obtained good results. To confirm the potency of our technique, we examined our technique on the ROC centered retinal data source, which is mainly used for recognition of MAs.

The remainder of this paper organized as follows: Section I presents basic introduction and overview of the Diabetic Retinopathy in retinal images. Section II presents FCM Clustering algorithm with proceedings of histogram analysis of the microaneurysms detection in retinal images. Section III presents Performance evaluation proposed approach with diabetic retinal images. Section IV presents comparison analysis of Rotating Cross-Section Profile Analysis and Fuzzy C-Means clustering algorithm. Section V presents conclusion and further enhancement of developed approach.

2. FCM APPROACH

The picture is obtained from the picture resources. This obtained picture will be turned into gray scale picture to be able to execute the picture research in more efficient way. The unclear factors are set centered on various requirements such as variety of groups, variety of iteration and picture sizing [4].

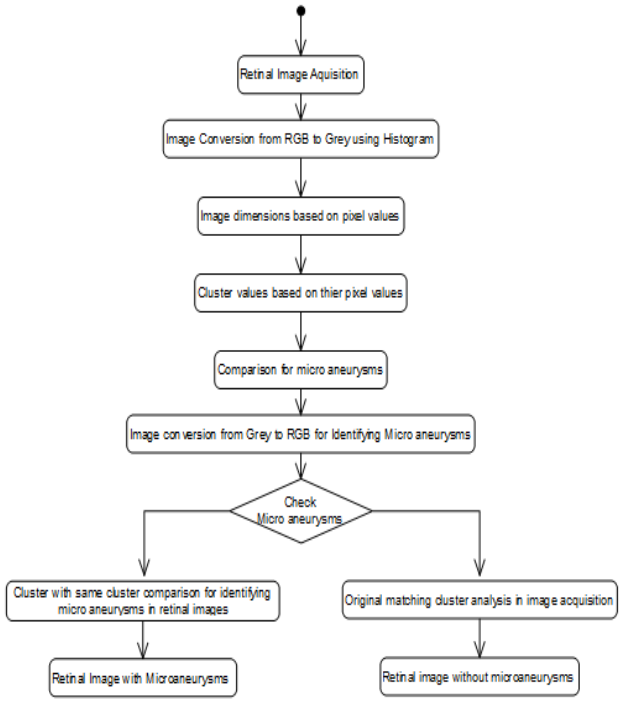

Figure 2: Proposed approach operations Using Fuzzy c-Means Clustering.

The input image is examined because the Customized Spatial Fuzzy CMeans clustering is applied on 2D or 3D images. The input picture is turned in various perspectives to recognize the perfect centroid over various information places. The benefits of spatial spinning are to discover out the likeness actions for detecting microaneurysms in the retina pictures. The unclear factors such as account operate, objective function and centroid are used to discover a group in an efficient way to get the great clustering amount. The distance of the information places are recognized depending on the fuzzy factors i.e., the range evaluate over the data factors are measured. The groups are formed based on the spatial unclear factors and also compared with regular cup with same position of spinning. If two group information over spatial unclear are same then the eye is not suffering from the microaneurysms otherwise the eye is affected by the microaneurysms.

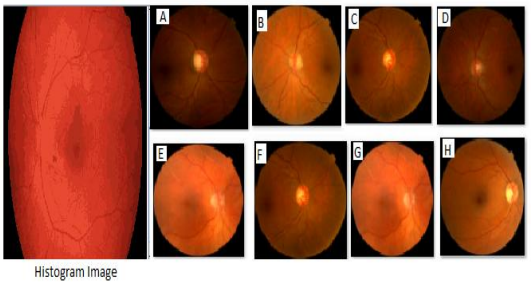

Figure 3: A, B, C, D, E, F, G, H Original Retinal images, and histogram image.

The histogram of the feedback pictures are evaluated based on various shifts. There are various groups established with several perspectives of spinning. If there is an incident of an angle distinction then the range from the centroid also differs, so the histogram provides the finish research of spatial factors.

3. PROPOSED FCM APPROACH WITH NLM ANISOTROPIC DIFFUSION FILTER

The non-local means algorithm does not make the same assumptions about the image as other methods. Instead it assumes the image contains an extensive amount of self-similarity. Before going to develop NLM Anisotropic Diffusion filter we will discuss about NLM Methods. Each pixel *p* of the non-local means denoised image is computed with the following formula:

$$NL(V)(\mathrm{p}) = \sum_{q-v} w(p,q)V(\mathrm{q})$$

Where *V* is the noisy image, and weights *w (p,q)* meet the following conditions and Each pixel is a weighted average of all the pixels in the image. The weights are based on the similarity between the neighborhoods of pixels *p* and *q* [1, 2].

The herein suggested recognition technique includes two primary phases: preprocessing and FCM-Based identification as is consistently described by the running prevent diagram.

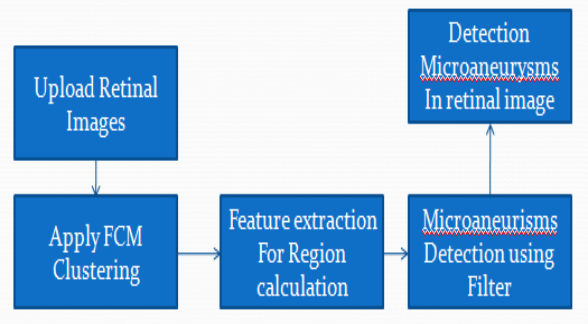

Figure 4: Proposed architecture process.

Figure 3 shows effective micro aneurysms detection with upload retinal images and then apply FCM Clustering and then apply feature extraction with proceedings of region and calculation of all the semantic data of both retinal and non-retinal data processing for micro aneurysms detection in uploaded retinal images.

4. IMPLEMENTATION PROCEDURE OF FCM

Fuzzy clustering is one of the most commonly used fuzzy techniques in picture segmentation of the retinal pictures. It is an repetitive criteria. FCM can be used to develop groups (segments) where the category account of p can be considered as the level of belongingness of the pixel to the groups.

Let $A = \{x1, x2, x3, \ldots . xn\}$ signify a set of p of the given picture, where n is the variety of pixels and $B = \{v1, v2, v3, ----vc\}$ is the corresponding set of unclear group facilities, where c is the variety of groups. The primary aim is to reduce the purpose operate J (U,V), which is a squared mistake clustering requirements described as :

$$J(\mathrm{U},\mathrm{V}) = \sum_{i=1}^{n}\sum_{j=1}^{c} \mu^{m}{}_{ij} \,\|\, x_i - v_j \,\|^2 \text{ ---- (1)}$$

Where $\|\, Xi - Vj \,\|^2$ is the Euclidean distance between xij and vj. µij is the account level of pixel xi to the cluster center vj and ìij has to fulfill the following conditions:

$$\mu_{ij} \in [0,1], \forall_i = 1.....n, \forall_j = 1.....c \text{ --- (2)}$$

$$\sum_{j=1}^{c} \mu_{ij} = 1, \forall_{i=1.....n}$$

$$0 \le w(p,q) \le 1 \qquad \sum_q w(p,q) = 1$$

$U = (\mu)_{ij_{n*c}}$ is a fuzzy partition matrix. Parameter m is known as the • fuzziness index; it is used to management the fuzziness of account of each pixel. The value of m should be within the variety $m \in [1, \gamma]$. m is a weighting exponent that meets m >1 and manages the level of fuzziness in the causing account functions: As m techniques oneness, the account features become sharper, and strategy binary features. As m increases, the account features become progressively fuzzy.

FCM algorithm procedure as follows:
Initialize the cluster centres V = {v1, v2…., vc}, or initialize the membership matrix µ*ij* with random value such that it satisfies conditions shown in above.

Calculate the fuzzy membership µ*ij* using:

$$\mu_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{d_{ij}}{d_{ik}}\right)^{\frac{2}{m-1}}} \text{ ---------- (3)}$$

Compute the fuzzy centres v*j* using:

$$v_j = \frac{\sum_{i=1}^{n} (\mu_{ij})^m x_i}{\sum_{i=1}^{n} (\mu_{ij})^m}$$

This is the procedure of the fuzzy c-mean algorithm in in cluster present in progressive data environment and in image verification processes. Develop this procedure in section III for clustering verification of the matching events present in the processing events.

5. PERFORMANCE EVALUATION OF FCM

The microaneurysms is measured centered on various spatial factors over the fundus images. We process and extract the different features related to different retinal images which microanyrisms as problem in retinas then we upload those images to our developed proposed technique fuzzy c-means clustering algorithm.

Mathematical Analysis of the Microanyrisms Detection: Fuzzy C-Means Clustering algorithm compares two images which belong to same cluster with membership value in different angles of rotation. Image representation of the pixels in different formation,

$$I_1 = \begin{bmatrix} r11 & r12 & ..... & r1n \\ r21 & r22 & ..... & r2n \\ ..... & ..... & ..... & ..... \\ rm1 & rm2 & ..... & rmn \end{bmatrix} \text{---------- (4)}$$

Another representation of retinal image format as follows

$$I_2 = \begin{bmatrix} r11 & r12 & ..... & r1n \\ r21 & r22 & ..... & r2n \\ ..... & ..... & ..... & ..... \\ rm1 & rm2 & ..... & rmn \end{bmatrix} \text{---------- (5)}$$

The pictures are turned in various position then the outliers are quickly recognized from the feedback image. The RGB Image is converted to gray scale image for further processing.

$$I_1 = X[\theta[I_1]]$$
$$I_2 = X[\theta[I_2]] \text{---------- (6)}$$

The noise is removed by using filter for efficient processing of the image

$$I_1 = Filter[X[\theta[I_1]]] \text{---------- (7)}$$

$$I_2 = Filter[X[\theta[I_2]]] \text{---------- (8)}$$

The above equation shows filter comparison for micro aneurysms detection in uploaded retinal images. In Fuzzy C-Means Clustering SVM (Support Vector Machine) Classification technique was used to classify the uploaded retinal image contain micro aneurysms or not based on formal or uniformly retinal images. The center of the image with respective angle of rotation with processing of application development may applied efficient and effective angular rotation.The image comparison and final detection of microanyrisms as follows:

Image Comparison:

$$\begin{Bmatrix} True & if((I_1 \cup MF \cup C \cup 0F) \\ & \cap(I_2 \cup MF \cup C \cup 0F)) = \phi \\ false & otherwise \end{Bmatrix} \text{---- (9)}$$

Where I is number of iterations, MF is maximum false positive rate with processing of each cluster based on their relevance of matching content of uploaded retinal image.

The result of the comparison pixels in above equation as follows:

$$\begin{Bmatrix} \text{Im}age - Comparison = true, NoMicroanyrism \\ \text{Im}age - Comparison = false, Microanyrism \end{Bmatrix}$$

By using this equation we process efficient comparison of the cluster analysis in fuzzy c-means with processing of pixels in commitment and other proceedings in data of retinal images.

6. PERFORMANCE EVALUATION OF FCM WITH NLM IN TERMS OF ANISOTROPIC FILER

As shown in equation 7 and 8, we present to use different Filter for reduction of microaneurysms in uploaded retinal images which include different dimensional processing in data images. To be able to get over the drawbacks in both FCM and SVM Classification Filter, we are presenting a new criterion, which is a mixture of both NLM and Anisotropic. In the new criteria, we are modifying the Gaussian filtration parameter in NLM as it is a purpose for computational complexness. We are suggesting NLM in terms of ANISOTOPIC.

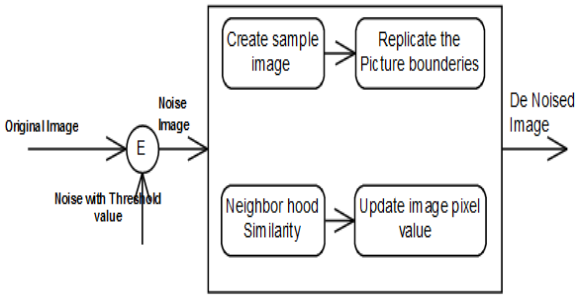

Figure 5: Image restoration block diagram.

The mathematical expression for NLM is

$$NL[U](x) = \sum_{j\varepsilon 1} w(a,b)v(y) \text{ ---------- (10)}$$

Where $w(a,b) = \frac{1}{z(x)} e^{\frac{-\|v(N_a)-v(N_b)\|^2}{h^2}}$

Here, z(x) represents Gaussian equation

In the proposed algorithm, we are replacing z(x) with the biweight function of ANISOTROPIC filter.

As comparison of the earliest technique of FCM with SVM we process to use NLM Anisotropic Filter in FCM for processing image very flexible analysis and calculate different dimensions in pixel value presentation with proceedings for micro aneurysms detection in uploaded retinal images. The mathematical equation for the proposed algorithm is

$$NL[U](x) = \sum_{j\varepsilon 1} w(a,b)v(y)$$

Where $w(\mathrm{a},\mathrm{b}) = \frac{1}{k_3(x)} e^{\frac{-\|v(N_a)-v(N_b)\|^2_{2a}}{h^2}}$

Here $k_3 = \frac{1}{2}[1-(\frac{x}{k\sqrt{2}})^2]^2$

By the implementation of these filtering processes in FCM Clustering Technique we present to develop efficient microaneurysms detection in uploaded retinal images.

7. EXPERIMENTAL RESULTS

In this section we observe three algorithms for processing efficient and effective micro aneurysms detect ions when ever process of uploading images. For doing this work we upload different type of retinal images related to different pixel rotation and other proceedings in real time retinal data images from ROC based image repository processing units. Sample images are used as follows:

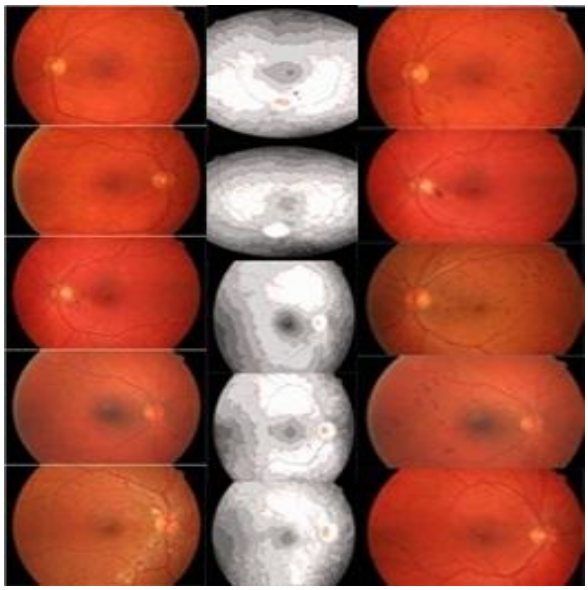

Figure 6: Sample images shows Comparison of Cross- site analysis, Fuzzy C-Means Clustering and FCM with NLM in terms anisotropic Diffusion filter with micro aneurysms detection for proceedings of different retinal images. Column 1 gives the information about five sample inputs. Column 2 provides information about corresponding histograms of the inputs. Column 3 provides details of NLM anisotropic method result.

Above diagram show comparison of earlier and latest technologies like FCM and FCM with NLM in terms of Anisotropic Diffusion filter was used to process Gassian parameter for proceedings of different types of retinal images. We calculate time efficiency for proceedings different type of images with proceedings of all the features of uploaded images.

Table 1: Time calculation of different uploaded retinal images

Uploaded Retinal Images	Rotational Cross sectional Analysis	Fuzzy C-Means Clustering	FCM with NLM in terms of Anisotropic Filter
1	2.7845	3.2359	4.5885
2	1.9874	2.7714	2.9744
3	0.9854	1.9549	2.8386
4	1.2452	1.8842	3.5660
5	2.0145	2.6829	2.7261

Time efficiency is also maintain for calculating micro aneurysms in retinal images of both FCM and NLM based Anisotropic Diffusion Filter process for detections of micro anyrisms as shown in the Table 1.

We observe that processing's of these three techniques used for detection of micro aneurysms in uploaded retinal image specification may follow different time intervals for micro data retrieval in emerging process of uploaded retinal images. The sensitivity curve also shown below for the three techniques.

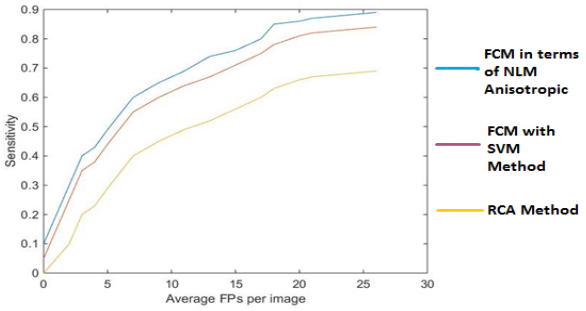

Figure 7: ROC Curve

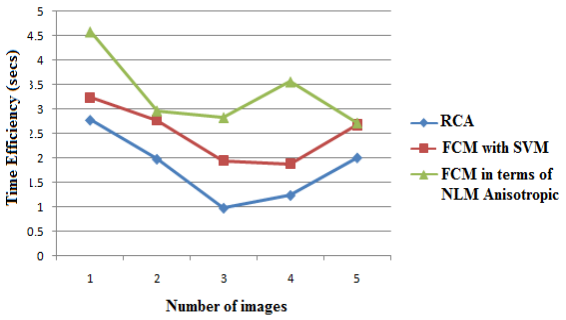

Figure 8: Graphical Analysis of proposed approach with RCA method.

The range of retina pictures used in our research is relatively large and the handling time can reduce relatively according to the range changes. Furthermore, OpenCV Tool is a development environment, which can also affect time intake. In addition, because most of the related sets focus around the visual hard drive and boat network, effective meaning of Area of Interest also can help to reduce time intake. Above all, the iterated spatial anisotropic sleek reduces the uninformative key points and have reduced time intake of the retinal recognition system.

8. CONCLUSION

In this work we proposed an efficient MA detection algorithm in retinal images. The identification of MAs is an essential step in the diabetic retinopathy. We used Fuzzy clustering for segment the pixels information further NLM in term of anisotropic filter is applied to improve identification of micro aneurysms in retinal images. The results show that our method improves the micro aneurysm detection rate and got ROC score 0.427.Tested on the various simulated retina data repositories combining rotation and scaling, the developed method presents promising results and shows robustness to rotations and scale changes.

FurtherThis method can also be applied for bright lesions detection in fundus images as well as massive false positive reduction for mammograms.

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