ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 5, May 2015

A Diabetic Retinopathy Detection Using Fuzzy Local Information C-Mean and Kernel Metric with non-Euclidean distant metric

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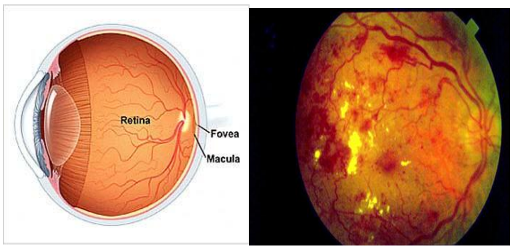
Abstract: Image processing plays a main role in the detection of the any kind of disease into any part of the body in medical field. Nowadays, medical imaging for extracting the diseases directly into a computer is getting more wide. Likewise, in the proposed system the focus is on to the diabetic retinopathy disease which is caused into retina of eye and further leads into the poor vision/blindness. Here, the exudate eye disease is segmented from an image by using the segmentation method. For segmentation the most widely used fuzzy clustering method is proposed. Fuzzy local information c-mean algorithm is used with introducing a kernel metric. It is further modified by using non-Euclidean distance metric and the parameters are calculated for justifying the best detection result.

Keywords: Diabetic Retinopathy Retinal Image, Exudate Eye Disease, KWFLICM algorithm, non- Euclidean distance metric.

I. INTRODUCTION

Image processing is a technology that is spreading fast for extracting the main information from an entire image. Segmentation plays the main role of extracting the information that is required. Thus, segmentation is the key technique which is widely used in many applications. The wide use of segmentation is in the field of medical science where the disease is to be detected. Many technologies have been invented for detection of disease from any part of the body.

Nowadays, the much higher rate of disease increasing all over the world is diabetes. When the diabetic increases to proliferative n non- proliferative extent, this causes defects into the blood vessels of the retinal eye. There causes a leakage into blood vessels and leads into poor vision and blindness. So, according to survey from many doctors, they have tried on detecting the Exudate eye disease from different angles. The original retina image and the diabetic affected disease image is shown.



a. b.

Fig 1: (a) Actual retinal image, (b) Exudate Diabetic retinopathy retinal image.

For the segmentation of the Exudate eye disease from the retinal image clustering techniques were applied. The clustering technique is the best segmentation type among other techniques. The blood vessel as shown in fig 1: (b) is defected due to diabetes.

The yellow and black patches are the disease which is located near by the blood vessels. For the segmentation of the Diabetic retinopathy retinal image Fuzzy clustering methods were applied [1]. The most popular Fuzzy method used for segmentation is FCM (Fuzzy C- Mean) method. FCM was applied on the diabetic retinal image for the segmentation of the actual disease and also processed taking out the intensity value and its ground truth image [2]. Many Fuzzy clustering techniques were applied to medical images. Now here, in this proposed system, the FCM (Fuzzy C-Mean) technique is modified with the addition of trade-off weighted fuzzy factor G_{ki} with the kernel metric.

II. FUZZY C-MEAN METHOD

FCM is the most popular clustering method used for the segmentation of image because it retains more information than any other technique. It is a iteration based algorithm. The objective function of the FCM for partitioning the data set is given as:

$$J_m = \sum_{i=1}^{N} \sum_{j=1}^{c} u_{ji}^{m}\, d^2(x_i, v_j),$$

Where,

V_j is the centre or prototypes of the cluster.

u_{ji}^{m} Represent a partitioning matrix.

C is the cluster number.

M is the membership value.

The basic steps of FCM are followed:

a) Set the values of c-cluster, m-dimensional and e-stopping iteration value.

b) Now, initialize the Fuzzy partitioning matrix U^0,

c) Give the loop counter b = 0,

d) Calculate the c- cluster center v_j^b with U^b.

ISSN (Online) 2278-1021
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International Journal of Advanced Research in Computer and Communication Engineering
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$$v_j^b = \frac{\sum_{i=1}^{N}\left(u_{ji}^b\right)\hat{}m.\ x_i}{\sum_{i=1}^{N}\left(u_{ji}^b\right)\hat{}m}$$

e) Calculate the membership metric function $U^{(b+1)}$:

If max { $U^b - U^{(b+1)}$ } < ε then stop , otherwise set b = b+1 and go to step 4.

III.INTRODUCING TRADE-OFF WEIGHTED FUZZY FACTOR G_{ki}:

The fuzzy factor G_{ki} characteristic is followed:

1. Incorporate the local gray level information and the spatial in fuzzy way for robustness and insensitive to noise.
2. It's free of parameter.
3. Also control the influencing of neighboring pixel depending on their distance from central pixel.

The fuzzy factor G_{ki} is the parameter free and this factor controls the balance between the image detail and the noise. The fuzziness is applied on each of the pixel on both the local spatial and gray level. The novel fuzzy factor is given as:

$$G_{ki} = \sum_{\substack{j \in N_i \\ i \neq j}} \frac{1}{d_{ij}+1}\left(1-u_{kj}\right)^m . \left\|x_j - v_k\right\|^2$$

K is reference cluster;
J^{th} pixel belongs to set of neighbor fall into window around the i^{th} pixel (N_i).U_{kj} is the degree of membership of the j^{th} pixel in k- cluster.V_k is the prototype of center of cluster k.

The objective function is given as:

$$J_m = \sum_{i=1}^{N}\sum_{k=1}^{c}[u_{ki}^m]\ \|x_i - v_k\|^2 + G_{ki}$$

Firstly, set the c-cluster , m and e- stopping criteria as in FCM.
Then initialize the fuzzy partitioning method randomly and after set the loop b = 0.
Calculating the U_{ki};

$$u_{ki} = \frac{1}{\sum_{j=1}^{c}\left(\frac{\|x_i - v_k\|^2 + G_{ki}}{\|x_i - v_j\|^2 + G_{ji}}\right)^{\frac{1}{m-1}}}.$$

Calculate centroid cluster:

$$V_k = \frac{\sum_{i=1}^{N} u_{ki}^m x_i}{\sum_{i=1}^{N} u_{ki}^m}$$

If max { $U^b - U^{(b+1)}$ } < ε then stop , otherwise set b = b+1 and go to step 4.

G_{ki} is automatically determined in any kind of noise also. FLICM is the robust method proved for the outliers. Further onto the objective function of FLICM kernel metric was also introduced.

IV.KERNEL METRIC[3]

A. *Kernel Metric With Euclidean Distance:*

Nowadays the most in trend is a machine learning work which is generally used for converting the linear algorithm into the non-linear version. This is achieved by the kernel metric. The kernel metric method supports the SVM (support vector machine). The kernel metric is used for transforming the complex non-linear data into original low-dimension feature space. This exploits the spatial contextual information of an image data.

According to aforementioned algorithms, a Euclidean distance metric were used in the objective function of FCM or FLICM[]. In the existing KWFLICM algorithm [] also, a Euclidean distance metric was used which computes the roots of square difference between co-ordinates of pair objects. But this leads to unsatisfied result on segmentation when it is corrupted by noise or outliers or any other image artefacts.

B. *Kernel Metric With Non-Euclidean Distance:*

The Euclidean distance metric is replace by using the L_p norm i.e, non-Euclidean distance. This overcomes the problem of Euclidean norm. By introducing the non-Euclidean distance with the kernel metric is represented as:

$$K(x, y) = < \phi(x) , \phi(y) > ;$$

Φ (.) is a non- linear map whereas, < ϕ(x) , ϕ (y) > is a inner product simulation. Now using the non-Euclidean distance into the objective function is given as:

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{c} u_{ki}^m \ \|\emptyset(x_i) - \emptyset(V_k)\|^2 + G'_{ki},$$

The substitution of the kernel function results is followed as:

$$\|\emptyset(x_i) - \emptyset(v_k)\|^2 = K(x_i , x_i) + k(v_k , v_k) - 2k(x_i , v_k)$$

Smallest the value of variance, cluster gets compact and are very well separated around the cluster center. For this a bandwidth based on distance variance for all the data's collected is used, and is given as:

$$\sigma = \left(\frac{1}{N-1}\sum_{i=1}^{N}\left(d_i - \bar{d}\right)^2\right)^{1/2}$$

The distance variance used states the degree of aggregation near the cluster. The value of variance becomes large if the date set with fuzzy.There are many non-Euclidean distance metric used where, GRBF is widely used.

V. METHODOLOGY

A. *Proposed KWFLICM Algorithm:*

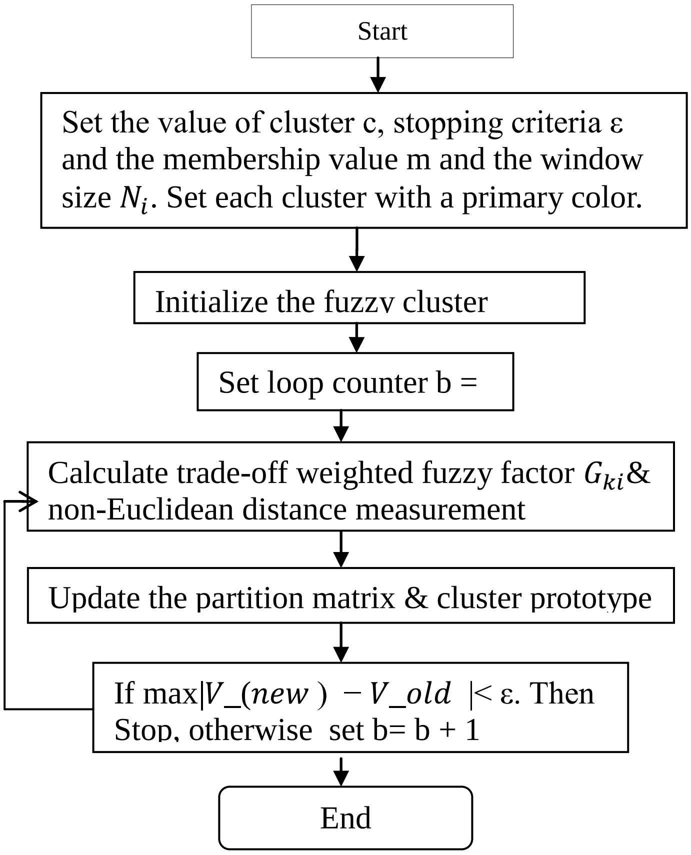
The algorithm of KWFLICM is same as the FCM/ FLICM:

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 5, May 2015

a) Set the values of c-cluster, m-dimensional and e-stopping iteration value and the window size N_i.
b) Now, initialize the Fuzzy cluster prototype,
c) Give the loop counter b = 0,
d) Calculate the trade-off weighted fuzzy factor w_{ij} and the Non- Euclidean distance measurement.
e) Update the cluster center and the partition matrix.
f) If max$|(new) - V(old)| <$ ε. Then Stop, otherwise set b= b + 1 and go to 4th step.

After this process, defuzzification starts just to convert the image into crisp image.



/Fig: 4: Flowchart of proposed Kernel metric FCM with Euclidean distance metric method For Segmentation.

B. *Experimental Result:*

The two methods were implemented onto the segmentation of the EXUDATE eye disease detection. Four images were taken of different patient and the above mentioned method was applied and results were obtained.

In the proposed method, the result is obtained in the color format which becomes easy to recognize the smallest portion of the disease. By changing the result from grey to color makes an easy way for getting information even in absence of the doctor.

Different patient eye image were collected from the eye hospital for the testing and the segmentation of the Exudate eye disease. The color result is obtained by assigning each cluster a different color.

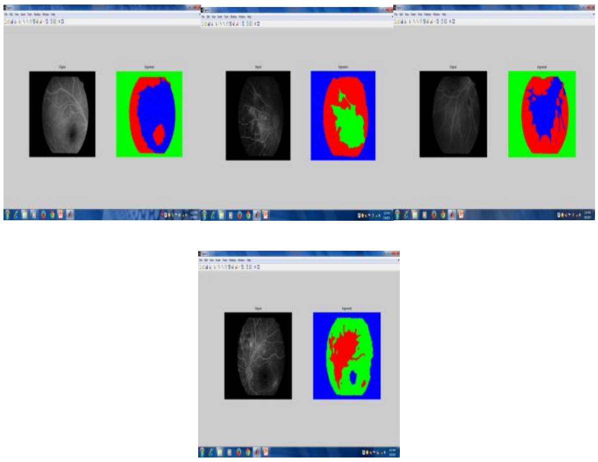


Fig 2: obtained result of KWFLICM with Euclidean Distance

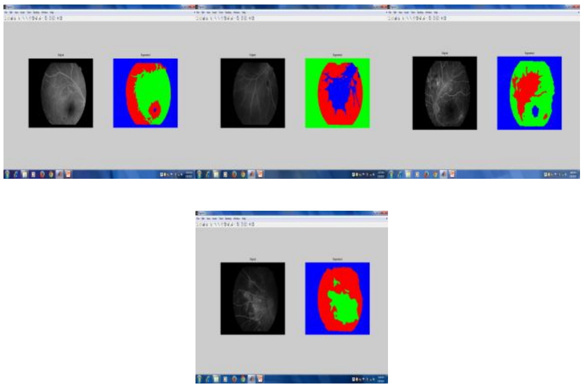


Fig 3: Obtained result of Proposed KWFLICM with non-Euclidean Distance

The implementation of the proposed algorithm was done on the MATLAB simulation. The segmentation of the Exudate Eye disease was obtained in the color image which retains the more information. Thus, this method was tested onto the four patient diabetic retinal images.

Aforementioned segmentation of MRI image result was in the gray image in which it is not clearly visible of about smallest portion of disease. Here, in the proposed method the smallest disease part is also segmented.

VI. COMPARISON TABLE

In this section, we compare the PSNR, MSE, L2RATIO and the Absolute Difference of the four images for the original existing KWFLICM with Euclidean distance and our proposed method KWFLICM with non-Euclidean distance.

We can observe that the image quality index parameters are improved for our proposed method. PSNR is the peak signal to noise ratio which shows the ratio between the original image and the compressed image. PSNR is defined by the MSE (Mean Sqaure Error).

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TABLE 1:

.Sr. no :	IMAGE	METHOD	PSNR	MSE	MAX ERR	L2RATIO
1.	IMAGE 1	KWFLICM method	92.323	6.04e+03	150	1.87
		Modified KWFLICM	98.6211	1.415e+03	82	2.25
2.	IMAGE 2	KWFLICM Method	96.0122	2.584e+03	124	6.5752
		Modified KWFLICM	98.6229	2.82e+03	130	7.008

Table 1: Comparison of two patient diabetic retinopathy image segmentation calculated parameters.

VII. CONCLUSION AND FUTURE WORK

According to the literature for segmentation of Exudate Disease using the FCM method, has proved to be the best segmentation. But, there was a disadvantage as it does not segment the smallest disease on retina. The smallest disease is not detectable by using FCM and FLICM. For that, KWFLICM method was proposed for the Exudate Retinal Image segmentation with introducing the non-Euclidean distance metric. The result was made more attractive and more informative by giving each cluster a RGB color. It was concluded that, KWFLICM with non-Euclidean, the smallest change in the gray value of pixel and its neighbour pixel is calculated. In Future, it can be converted into user friendly.

REFERENCES

[1] S. Krinidis and V. Chatzis, “A robust fuzzy local information C-means clustering algorithm,” IEEE Trans. Image Process., vol. 19, no. 5, pp.1328–1337, May 2010.

[2] Yan Liang, Jiao Shi, “Fuzzy c-Mean Clustering with Local Information and Kernel Metric for Image Segmentation.” IEEE trans. On image processing, vol. 22, No. 2, Feb-2013.

[3] X. Yang and G. Zhang, “A kernel fuzzy C-means clustering-based fuzzy support vector machine algorithm for classification problems with outliers or noises,” IEEE Trans. Fuzzy Syst., vol. 19, no. 1, pp. 105–115, Feb. 2011.

[4] S. Chen and D. Zhang, “Robust image segmentation using FCM with spatial constraints based on new kernel-induced distance measure,”IEEE Trans. Syst., Man, Cybern., B, Cybern., vol. 34, no. 4, pp. 1907–1916, Aug. 2004.

[5] Anandarup Roy, Swapan Kumar Purai, Amitav Paul “ A Color Based Image Segmentation & its Application” sixth indain onference on computer vision, image proessing-IEEE 2008.

[6] Akara Sopharak, Sarah Barman, “Automatic Exudate Detection From Non- Dilated Diabetic Retinopathy Retinal Images using Fuzzy C-Mean” Sensors articles ISSN- 1424-8220, Sensors-2009.

[7] L. Zhu, F. Chung, and S. Wang, “Generalized fuzzy C-means clustering algorithms with improved fuzzy partitions,”IEEE Trans. Syst., Man,Cybern., B, Cybern., vol. 39, no. 3, pp. 578–591, Jun. 2009.

[8] http://visionmd.org/2012/04/03/the-retina/

[9] www.eyeboston.com/Pages/Services/Surgery/Retina-Surgery.aspx

[10] http://www.aoa.org/patients-and-public/eye-and-vision-problems/glossary-of-eye-and-vision-conditions/diabetic-retinopathy?sso=y

[11] Huynh-Thu, Q.; Ghanbari, M. (2008). "Scope of validity of PSNR in image/video quality assessment". *Electronics Letters* **44** (13): 800. doi:10.1049/el:20080522