Updating Algorithm of Fuzzy Kohonen Clustering Network in Image Segmentation

Nahla Ibraheem Jabbar

***Abstract*—** This study derives a new interpretation for Fuzzy Kohonen Neural Network in parameter m .Derivation of new algorithm is accomplished by adaptive m. The learning rate in each iteration is effected by updating m ascending or descending .This yields automatic control to distribution of learning rate in the neighborhood of all data nodes at each iteration .This experiment evaluates the modified FKCN algorithm in terms of ability of segmentation of different regions in the image. Both the analytical and experimental data reported indicates that the choice of m in the range.

***Index Terms*—** Clustering, FCM, Fuzzy Kohonen Neural Clustering and Segmentation.

I. INTRODUCTION

SEGMENTATION an image consists of subdividing it into a number of non _overlapping ,homogeneous regions ,each of which is spatially connected and differs from neighboring regions in some meaningful properties .Segmentation is a process of partitioning the image into some non-intersecting regions that each region is homogeneous and the union of no two adjacent regions is homogeneous .It can be formally defined as follows : if F is the set of all pixels and p( ) is a uniformity(homogeneity)predicate defined on groups of connected pixels, then segmentation is a partitioning the set F into a set of connected subsets or regions $(s_1, s_2, ...s_n)$ such that

$$\cup_{i=1}^{n} S_i = F \text{ with } S_i \cap S_j = \phi, i \neq j \qquad (1)$$

The uniformity predicate $p(s_i)$ =true for all regions (s_i) and $p(s_i \cup s_j)$=false ,when s_i is adjacent to s_j [1].

There are many approaches developed for image segmentation. It is divided into four classes: classical, statistical, fuzzy and neural .Classical approaches include such methods as edge and Region-based techniques or intensity threshodling .Statistical approaches are based a maximum likelihood estimators represent learned classification rules as mathematical formulas. One popular fuzzy technique involves using fuzzy c-means(FCM) for image segmentation[2]. The neural network approaches have
been introduced which rely on a neural network architecture for image segmentation, also the hybrid of neural network with fuzzy is used in image segmentation[3][4].The hybrid learning scheme was a first attempt to merge fuzzy clustering and feature maps by Huntsberger and Ajjmarangsee[5] .They attempted to establish a connection between feature maps and fuzzy clustering by modifying the learning rule proposed by Kohonen for the SOFM . Hamdi used Fuzzy Kohonen neural network for image segmentation, in [6]. The theoretical foundations of this paper are based on theoretical foundations of Fuzzy Kohonen Neural Network in [7]. In this paper, we present a modified formulation of Fuzzy Kohohen Neural Network for image segementation.

Nahla Ibraheem Jabbar is a lecturer in the Electrochemical Engineering Department, University of Babylon, She is doctor researcher Babylon, Iraq (e-mail: nahla_jabbarr@yahoo.com).

II. FUZZY KOHONEN CLUSTERING NETWORK

Bezdek, Pal and Taso [6] considered this approach. , they extended the ideas of FCM and Kohonen neural network to a new family of algorithms called Fuzzy Kohonen Clustering Network (FKCN). The Kohonen Clustering Network (KCN) clustering is closely related to the Fuzzy c-Means (FCM) algorithms. Since Fuzzy c-Means algorithms are optimization procedure because the objective function is approximately minimized. The integration of FCM and KCN is one way to address several problems of KCN[8]. They combine the ideas of fuzzy membership values for learning rates, the parallelism of Fuzzy c-Means, and update rules of KCN. FKCN is self-organizing algorithm, since the "size" of the updated neighborhood is automatically adjusted during learning, and FKN usually terminates in such a way of minimized objective function of FCM.

III. FUZZY KOHONEN CLUSTERING ALGORITHM

The algorithm of FKCN is summarized as following [6],[7],[8]**:**

Step1: Given sample space $X = \{x_1, x_2, x_3, ..., x_n\}$ distance $\|.\|$
Cluster c and error threshold $\varepsilon > 0.$

Step2: Initialized the weight vector v(0),set fuzzy
Parameters m_0 iteration limit t_{max} ,initial iteration
Counter, t=0.

Step3: Update all memberships $\{u_{ij}\}$ and calculate learning
Rate $\{\alpha_{ij}\}$.

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{\|x_i - v_i\|}{\|x_j - v_k\|}\right)^{\frac{1}{(m_t - 1)}}} \qquad (2)$$

$$\alpha_{ij}(t) = (u_{ij}(t))^{mt} \qquad (3)$$

ISBN: 978-988-19253-7-4
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

$$\text{where } m_t = m_0 - t.\Delta m, \Delta m = \frac{m_0 - 1}{t_{max}} \quad (4)$$

Step 4: Update all the weight vectors.

$$v_i(t) = v_i(t-1) + \frac{\sum_j^n \alpha_{ij}(x_j - v_i)}{\sum_{s=1}^n \alpha_{js}(t)} \quad (5)$$

Step5 : Compute the function

$$E(t) = \| v(t) - v(t-1) \| \quad (6)$$

Step6: If $t+1 > t_{max}$ or if $E(t) < \varepsilon$, and terminate the iteration; otherwise, return step3.

IV. ANALYSIS OF FKCN

FKCN is the heuristic learning neural network .It can find the clusters center and partition the feature by distance, to overcome the problem of KCN for updating the non winner prototypes in the determination of learning rate [7].

To evaluation the performance of FKCN, it depends on the affective factors of behavioral FKCN. In our experiments we can obtained, the m (fuzzy parameters) is the most effective parameter in behavioral of FKCN because updating of parameter m in each iteration .This yields automatic control to distribution the learning rate and update the neighborhood are effectively to all data nodes at each .Also learning rate related to the parameter m ,from studying the equation (4) ,the updating of $m(t)$ changed in each iteration in ascending order. There are three cases of m in FKCN depending on choice of the initial m_0 and final mf are :[10]

1. $m_0 > m_f \Rightarrow \{m_t\} \downarrow m_f$ Descending (7)
2. $m_0 = m_f \Rightarrow m_t = m_0 = m$ (8)
3. $m_0 > m_f \Rightarrow \{m_t\} \uparrow m_f$: Ascending (9)

The first one, it had been discussed in the [11], and the second case when m is constant in all iterations of FKCN algorithm, in is case of FKCN equal to the FCM and the third updating is described in [7][8] ,also we applied a experiment for image segmentation. The updating effected by equation in (4) where m updated in ascending order and Δm related to the m_0 and t_{max} , these parameters are defined from user selection, also the stability of FKCN respected to the parameters of m_0 and t_{max} **.** When increase the number of maximum iteration, the change in Δm it will be decrease with each iteration and stopping in the t_{out} (represented termination at iteration t).

$$\forall t \in \{1, (t_{max} - 1)\} \quad (10)$$

Sometimes the termination reached at iteration t_{out} , before the execution the total number of iterations .From experiment(4),we deduced the values of m_0 between (0-1) and the best results of segmentation in values of m_0 between(0.5-0.9).It is very clear in the experiment , the updating m of is ascending order ,but the final value of m_f is less than one. The stability of FKCN reached in m_f must be less than 1.

V.EXPERIMENT

The goal of this experiment is to test the effective of maximum of iteration t_{max} and initialization value m_0 in the behavioral of FKCN .When the t_{max} between (100-1000) and m_0 (0.5-0.9) with $\varepsilon = 0.0001$, c=6. Fig 1. Shown the relation between the of number of maximum iteration and termination iteration,the result of lena image segmentation image in Fig 2(a, b).Table (1) is explained the results of the experiment .

TABLE I

Explain the relation in FKCN between the maximum number iterations with final value of m when m_0 =0.5, 0.6, 0.7, 0.8 and 0.9 $\varepsilon = 0.0001$, c=6

t_{max}	m_0 =0.5 m_f =	m_0 =0.6 m_f =	m_0 =0.7 m_f =	m_0 =0.8 m_f =	m_0 =0.9 m_f =
100	0.9950	0.9960	0.9970	0.9960	0.9930
200	0.9975	0.9960	0.9940	0.8570	0.9275
300	0.9950	0.9933	0.7408	0.8340	0.9203
400	0.9938	0.7130	0.7360	0.8150	0.9160
500	0.7130	0.6808	0.7108	0.8232	0.9098
600	0.6858	0.6280	0.7270	0.8237	0.9115
700	0.6671	0.6135	0.7176	0.8117	0.9098
800	0.6519	0.6107	0.7150	0.8150	0.9060
900	0.6389	0.6231	0.7190	0.810	0.9054
1000	0.627	0.6132	0.7174	0.8102	0.9042

ISBN: 978-988-19253-7-4
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

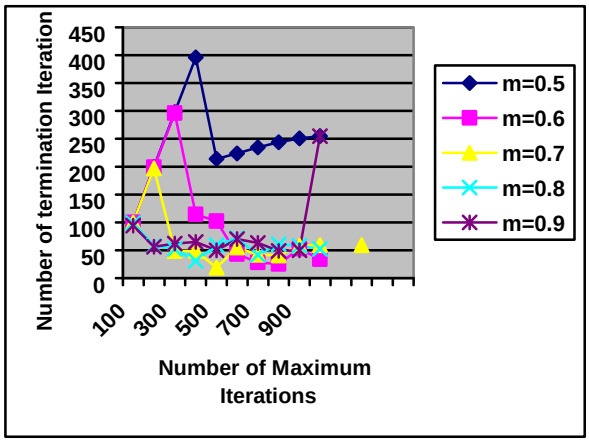

Fig.1 plot the relation of termination iteration with Maximum number of iteration

Fig.2 (a) Shows an image of lena

Fig.2.(b) Results segmentation of FKCN

VI. MODIFIED OF FKCN ALGORITHM

We summarized the algorithm of modification of FKCN as follows:

Step 1: Given sample space $X = \{x_1, x_2, x_3, ..., x_n\}$ distance $\|.\|$ number of cluster c and error threshold $\varepsilon > 0$.

Step 2: Initialized the weight vector v(0),set fuzzy parameters m_0 iteration limit t_{max} ,initial iteration counter t=0.

Step 3: Update all memberships $\{u_{ij}\}$ and calculate learning rate $\{\alpha_{ij}\}$.

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{\|x_i - v_i\|}{\|x_j - v_k\|}\right)^{\frac{1}{(m_t - 1)}}} \qquad (11)$$

$$\alpha_{ij}(t) = (u_{ij}(t))^{mt} \qquad (12)$$

$$m_t = \Delta m.(t-1) - m_0 \qquad (13)$$

$$\text{where } \Delta m = \exp\left(-\frac{m_0 - 1}{t_{max}}\right). \qquad (14)$$

Step 4 : Update all the weight vectors

$$v_i(t) = v_i(t) + \frac{\sum_{j}^{n} \alpha_{ij}(x_j - v_i)}{\sum_{s=1}^{n} \alpha_{js}(t)} \qquad (15)$$

Step 5 : Compute the function

$$E(t) = \|v(t) - v(t-1)\| \qquad (16)$$

Step 6 : If $t+1 > t_{max}$ or if $E(t) < \varepsilon$,

terminate the iteration ;otherwise ,return step3.

VII. EXPERIMENT

The goal of this experiment is to test the effective of the proposal algorithm .When the t_{max} between(100-1000) and m_0 (0.5-0.9) with $\varepsilon = 0.0001$,c=6 ,the result of lena image segmentation the same results in Fig.2(a,b) The Table (2) are explained the results of the experiment ,also the Fig 3. Shown the relation between the number of maximum iterations t_{max} and the stopping termination iteration t_{out} .

ISBN: 978-988-19253-7-4
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

TABLE 2

Explain the relation in modified FKCN between the maximum number iterations with final value of m when m_0 =0.5, 0.6, 0.7, 0.8 and 0.9 $\varepsilon = 0.0001$, c=6

m_0 =0.5 m_f =	m_0 =0.6 m_f =	m_0 =0.7 m_f =	m_0 =0.8 m_f =	m_0 =0.9 m_f =
0.9980	0.8155	0.6683	0.5477	0.4489
0.9975	0.8171	0.6693	0.5483	0.4491
0.9950	0.7005	0.6670	0.5484	0.4492
0.9938	0.6570	0.6572	0.5485	0.4492
0.7130	0.6268	0.5181	0.5099	0.4354
0.6858	0.5993	0.5491	0.4822	0.4250
0.6617	0.5732	0.5217	0.4635	0.4112
0.6519	0.7788	0.5013	0.4512	0.4112
0.6389	0.5582	0.4992	0.4515	0.4079
0.6270	0.5543	0.4992	0.4528	0.4078

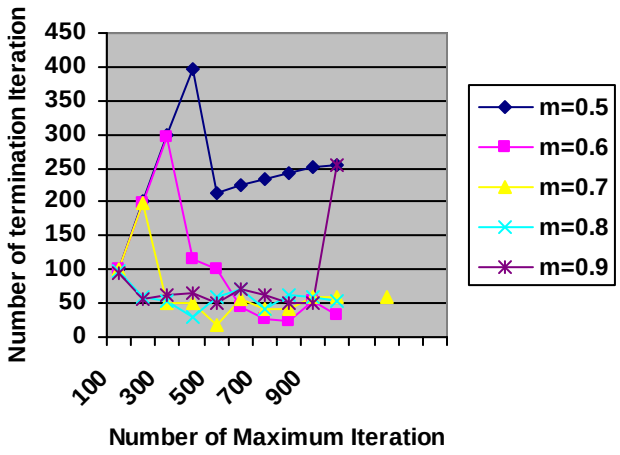

Fig.3 plot the relation of termination iteration with Maximum number of iteration

VIII. CONCLUSIONS

We evaluated the performance of the proposed system .Several experiments were done for image segmentation. It partitioned successfully the image into meaningful regions; the results are shown in Figures (1, 2). FKCN choose the change m_0 as a weighting exponent ,it is employed to calculate both the learning rate and degree of overlaps between neurons .From experiment in proposal algorithm, the best results of segmentation got in m_0 between(0.5-0.9) value m_0 must be less than one. Value m_0 equal 1 the performance of FKCN is equal to the FCM.

The stability of FKCN and mf related to the parameters of m_0 and $t_{\max}$,sometime the algorithm terminate in t_{out} before completing the total number of iteration in mf ,the value of mf tends to one.

From Table (1) the behavior of FKCN is assending but the Table (2), when the m_0 =0.5 and 0.6 is ascending but the number of iteration effect to decreasing from the number of iteration more that 500.When m_0 =0.7, 0.8 and 0.9 update decreasing. We can say the updating of learning rate increasing and decreasing, this gives the characteristic of adaptive during iteration.

REFERENCES

[1] N R. Pal, and S K .Pal, "A Review on Image Segmentation Techniques," Pattern Recognition, Vol.26, No.9, pp.1277-1294, 1993.Chen, Linear

[2] A M .Bensaid, L O.Hal, J.C.Bezdek , P.Clarke, M L.Silbiger,J.A"Validity-Guided (Re) Clustering with Applications to Image Segmentation, "IEEE Trans .Fuzzy Systems,Vol.4,No.2,May 1996..

[3] L.O.Hall,A.M.Bensaid,L.P.Clarke,R.P.Velthuizen,M.S.Silbiger and J.C.Bezdek, "A Comparison of Neural Network and Fuzzy Clustering Techniques in Segmenting Magnetic Resonance Image of the Brain, "IEEE Trans. Neural Networks,Vol.3,Iss.5,pp.672-682,1992.

[4] B. Xu, and S. Lin, "Automatic Color Identification in Printed Fabric Images by A Fuzzy Neural Network, "AATCC. Review,Vol .2,No .9,pp.42-45,2002

[5] T.Huntsberger,P.Ajjimarangsee, "Parallel Self-Organizing Feature Map For Unsupervised Pattern Recognition",Int.J.Gen.Syst.16,pp.357-372,1989.

[6] H. ATMACA,M. BULUT and D. DEMIR, " Histogram Based Fuzzy Kohonen Clustering Network for Image Segmentation, "IEEE 1996

[7] E. . Tsao ,J C.Bezdek and N.l R.Pal , "Fuzzy Kohonen Clustering Networks, Pattern Recognition,"Vol.27, No.5 pp.757-764 , 1994.

[8] M.S.Tarko,Y.Mun,J.Choi and H.Choi, "Mapping Aadaptive Fuzzy Kohoen Clustering Network onto Distributed Image Processing System",Praallel Computing ,28,2002.

[9] A. Baraldi and P.Blonda, "A Survey of Fuzzy Clustering Algorithms for Pattern Recognition__part2", IEEE Trans. System Man and Cybernetics___partB, Vol.29, No.6, pp.786-799, 1999

[10] A. Baraldi,P.Blonda, "Model Transitions in Descending FLVQ", "IEEE Trans. Neural Networks,Vol.9,No.5,Septemper 1998.

[11] J.C. Bezdek ,N .R .Pal and E .C .K .Taso, "Two Generalization of Kohonen Clustering",Reserch supported by NSF Grant Number IRI-9003252.

ISBN: 978-988-19253-7-4
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)